Eindverslag **Stage 3devo**

Verwarmde behuizing voor het 3D-printen van HDPE en PP

door

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Dit document is opgesteld voor de stage bij 3devo. Luca van Straaten is een student Elektrotechniek aan de Haagse Hogeschool te delft.

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Wijzigingen

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V1	17.11.2021	Luca	Eerste oplagen

Voorwoord

Dit ontwerpdocument is geschreven als documentatie van het eerste stagetraject van Luca van Straaten.

Dank gaat naar 3devo voor de mogelijkheid om bij hun mijn eerste stage te doen.

Dit verslag is bedoeld voor mijn stage beoordeler om te beoordelen of ik voldoende heb gepresteerd tijdens mijn stage, voor 3devo en de mensen die daar werken en verder moeten bouwen op mijn werk en voor Nederlandstalige geïnteresseerden in het project. Een Engels vertaalde versie van dit verslag is momenteel niet beschikbaar.

Utrecht, November 2021
Luca van Straaten

Inhoudsopgave

Lijst van figuren

Lijst van afkortingen

2D Twee dimensionaal

3D Drie dimensionaal

3mf 3D Manufacturing Format (3D-productieformaat)

AM Additive manufacturing (Additieve productie)

f360 Fusion 360

FDM Gefuseerde depositiemodellering (Fused deposition modeling)

HDPE High-density polyethylene (Hogedichtheidpolyetheen)

PE polyethylene (polyetheen)

PID proportional–integral–derivative (proportioneel–integraal–derivaat)

PP Polypropylene (Polypropeen)

stl Standard Triangle Language (Standaard driehoekstaal)

Lijst van begrippen

C++ programmeertaal gebaseerd op C

extruder Het gedeelte van een FDM 3d printer waar het filament mee door het hotend en de nozel word geperst

hotend Het gedeelte van een FDM 3d printer waar het filament smelt

Inleiding

Waar de reden tot creatie van dit verslag worden blootgelegd, de opdracht en het probleem worden beschreven en achtergrondinformatie word gegeven.

De opdracht is om aanstuur elektronica te maken voor een 3D-printer die HDPE en PP moet kunnen printen. Deze printer is ongebruikelijk omdat deze een verwarde kamer krijgt die tot 160 °C moet kunnen komen. De hypothese is dat een verwarmde werkruimte van een dusdanig hoge temperatuur, de problemen oplost die worden bevonden met het printen van HDPE en PP met een conventionele printer.

1 Wat is 3D-printen

3D-printen is een additieve productie (AM) methode. Dat betekent dat een product word opgebouwd vanaf nul, in tegenstelling tot subtractieve productie is er weinig of geen verlies van materiaal. Een andere vorm van additieve productie is bijvoorbeeld spuitgieten, maar hierbij zijn kostbare gietmallen nodig. 3D-printen vereist geen grote investering voor elk nieuw ontwerp, en is daarom uitermate geschikt om snel prototypen te maken. [2]

1.1 FDM 3D-printen

Er zijn verschillende vormen van 3D-printen, maar verreweg de meest populaire bij hobbyisten en kleinschalige bedrijven is FDM 3D-printen. FDM staat voor Fused deposition modeling, hierbij word steeds een laag materiaal op de vorige laag neergelegd (depositie) en daar op vast gesmolten (gefuseerd). Door herhaaldelijk laagjes op elkaar neer te leggen kan een 3D object woorden opgebouwd. Het plastic word gesmolten in het hotend en word door de extruder uit het hotend geperst.

1.2 3D-printer software

Er is verschillende software en firmware nodig om te kunnen 3d printen. Wat voor soorten software dat is staat hier onder beschreven.

3D bestanden

Software is nodig om een 3d object te ontwerpen, tijdens dit project is daarvoor f360 gebruikt. Ook kunnen bepaalde 3D objecten woorden gedownload van Thingiverse. Dit zijn meestal stl en 3mf bestanden.

Slicer

Gedurende dit project is de slicer *Prusaslicer* gebruikt, alle settings die gebruikt zijn om te slicen zijn op GitHub bijgehouden. Een slicer is software die een 3D bestand als een stl of 3mf, omzet in een hoop 2D lagen. Elke laag is gebruikelijk rond de 0.2 mm hoog. De printer *tekent* deze lagen en stapelt ze op elkaar, zo word een 3D object opgebouwd. In de slicer kan je veel dingen instellen om print kwaliteit of print snelheid te verbeteren. Instellingen zoals snelheid, temperatuur, flowrate en een hoop meer kun je tweaken voor een beter resultaat, deze instellingen zijn meestal printer afhankelijk.

1.3 3D-printer firmware

Firmware is een specifieke klasse van computersoftware die de controle op laag niveau biedt voor de specifieke hardware van een apparaat. Voor minder complexe apparaten (zoals 3D-printers) kan firmware fungeren als het complete besturingssysteem van het apparaat.

Een veel gebruiken firmware voor 3D-printers is Marlin en dat is ook waar voor is gekozen voor de 3D-printer. Marlin is een open source firmware voor de RepRap-familie van 3D-printers. Het is afgeleid van Sprinter en grbl en werd een op zichzelf staand open source project op 12 augustus 2011 met de Github-release. Marlin heeft een licentie onder GPLv3 en is gratis voor alle toepassingen [3].

Compiler

Een compiler word gebruikt om de firmware van de 3D-printer die in C++ is geschreven, om te zetten naar machinetaal. Machinetaal kan op de microprocessor worden uitgevoerd. Voor het compileren van Marlin is *Auto Build Marlin* een goede optie [4].

2 Wat zijn HDPE en PP

HDPE is een hoge dichtheid variant van PE. PE is een thermoplastisch polymeer dat in een breed scala aan toepassingen wordt gebruikt. HDPE is dus ook een thermoplast dat kan woorden geëxtrudeerd.

PP is tegenwoordig een van de meest gebruikte plastics. Het is een polymeer dat voornamelijk wordt gebruikt voor verpakkingen. HDPE is een thermoplast dat kan woorden geëxtrudeerd. Het wordt geproduceerd via ketengroeipolymerisatie uit het monomeer propyleen.

2.1 Waarom HDPE en PP

HDPE en PP hebben een aantal gunstige eigenschappen die ervoor zorgen dat het makkelijk te bewerken is. Daarom is de meerderheid van de gebruikte plastics voor verpakkings-materiaal gemaakt van HDPE en PP. Omdat een grote hoeveelheid van de afvalstroom daarom ook uit HDPE en PP bestaan is het gunstig om dat te kunnen recyclen om mee te 3D-printen.

3 Bestanden downloaden

Dit hele project is gewerkt in en is vastgelegd in git. Maar omdat de inhoud van het project en verslag intellectueel eigendom is van 3devo, staat dat openbaar op GitHub. Voor vragen over de inhoud van het project kun je contact opnemen met lucavanstraaten@icloud.com

1 Analyse van het probleem

Waar de noodzaak van dit project word blootgelegd.

Kortweg is het probleem dat er momenteel niet met HDPE en PP kan woorden ge-3D-print. 3D-printen met HDPE en PP is wenselijk omdat deze materialen overvloedig zijn is de huidige afvalstroom, en ze dus goedkoop te verkrijgen zijn.

Een voorbeeld van hoogwaardig PP in de afvalstroom zijn verpakkingen van medische goederen in ziekenhuizen. 3devo heeft PP bakjes van een oogheelkunde kliniek en wil dat recyclen tot 3D-printer filament. Zie Figuur 1.1 voor de bakjes.

Figuur 1.1: PP bakjes van een oogheelkunde kliniek

1.1 Waarom is een speciale 3D-printer nodig

Er zijn twee redenen gegeven waarom een speciale printer nodig is voor het printen met HDPE en PP. Tests zijn uitgevoerd om vast te stellen of deze complicaties werkelijk het printen van HDPE en PP onmogelijk maken.

1.1.1 Printen op een conventionele 3D-printer

Er is een test uitgevoerd met het printen van HDPE en PP. Deze test zijn uitgevoerd op een conventionele FDM 3D-printer, namelijk een Ender-3. De slicer settings die gebruikt zijn waren vooral getweakt op temperatuur en snelheid.

Figuur 1.2: Test print met HDPE op een conventionele printer

Figuur 1.3: Test print met PP op een conventionele printer

Laag hechting

De hypothese is dat bij het printen met PP de laag hechting niet goed zal zijn. Dat komt doordat PP onder de kristallisatietemperatuur niet ”plakkerig” is. De test met het printen van PP heeft geconcludeerd dat die hypothese waar is. Het materiaal blijft moeilijk plakken aan het bed, en als dat goed ging, blijft het ook nauwelijks plakken aan zichzelf. Zie Figuur 1.3. Een ander probleem met het printen van PP is dat het flexibele plastic niet goed door een bowden extruder gaat vanwege de extra weerstand in dat systeem. Uitleg over wat een bowden tube extruder is staat in hoofdstuk 4.1.1.

Krom trekken

De verwachting was dat het grote probleem met HDPE is dat het krom trekt tijdens het printen. Tijdens het printen zal er een warmte gradiënt ontstaan, omdat de laag die net is neergelegd al aan het afkoelen is voor dat de volgende de volgende laag daar op word gelegd. Tijdens het testen op een conventionele printer is vastgesteld dat dat inderdaad een probleem is, zie Figuur 1.2 voor een foto van de krom getrokken prints.

2 Eisen van het project

2.0.1 Randvoorwaarden

Het frame van een ender-5, de motoren van de ender-5, de behuizing, de warmte-elementen en de positie daar van waren allemaal al ontworpen voordat aan het project was begonnen. Dus deze aspecten van het project konden in principe niet veranderen.

2.0.2 Functionele wensen

De verwarmde kamer van de printer moet maximaal 160 °C kunnen woorden en stabiel zijn bij elke ingestelde temperatuur

2.0.3 Gebruikerswensen

De gebruikersinterface moet een eenvoudige en snelle manier zijn om de printer te gebruiken, dat betekent in principe dat de printer op dezelfde manier te bedienen moet zijn als de originele Ender-5

2.0.4 Ontwerpbeperkingen

Het project moet woorden gedaan in 10 weken. Dus er kunnen geen onderdelen woorden gebruikt met een lange levertijd.

De extruder en hotend kunnen niet op de conventionele manier woorden gekoeld omdat dezen zich in de verwarmde kamer bevinden. Dus als blijkt dat dezen gekoeld moeten woorden moet daar een andere oplossing voor woorden gevonden.

3 Problemen

Tijdens het project zijn eer paar problemen opgetreden. Dezen hadden allemaal te maken met de extruder en dat daar geen plastic meer uit komt (vast liep).

3.1 Smeltend plastic in de extruder

Een probleem waar al vrij snel tegen aan werd geloopen is dat de extruder vast liep door dat het plastic te vroeg smelten, met het gevolg er geen plastic meer uit de nozel kwam. Dit gebeurde telkens rond de zelfde tijd na het starten van een print.

3.1.1 Oorzaak

Dit probleem was het resultaat van warme drive gears (extruder tandwielen). Heat creep is een term voor het warmte gradiënt door de metalen onderdelen van de extruder. De stappenmotor van de extruder en de heater cartridge van het hotend produceren allebei warmte. Deze warmte geleid door de hele extruder assemblage en komt dus ook bij de drive gears. Als daardoor het plastic ook warm word smelt het in de extruder. En kan het dus niet meer door de nozel woorden geperst.

3.2 Dubbelvouwend plastic in de extruder

Een probleem tijdens het testen met een PP print wat dat het plastic dubbel vouwde in de ruimte tussen de extruder tandwielen en de glijder naar de extruder. Dit is dus een ander probleem dan beschreven in hoofdstuk 3.1, dit probleem treed eerder op en zelfs als de kamer niet is verwarmd. Dit probleem treden ook op tijdens het testen van PP op een normaale printer, echter om een andere reden.

3.2.1 Oorzaak

Dit komt doordat er genoeg ruimte is tussen de extruder tandwielen en het extruder frame dat er filament tussen door past. En omdat PP veel flexibeler is dan HDPE, gaat het makkelijk daar tussen zitten.

Dit probleem had een adere oorzaak bij het testen op een standaard ender-3. De oorzaak was echter dat de extruder veel meer kracht zou moeten zetten omdat de ender-3 een bowden extruder printer is. Uitleg over wat een bowden tube extruder is staat in hoofdstuk 4.1.1.

3.3 Kamer temperatuur overshoot

De temperatuur van de verwarmde kamer schiet door het setpoint heen voordat het stabiliseert of oscilleert rond de ingestelde waarden

3.3.1 Oorzaak

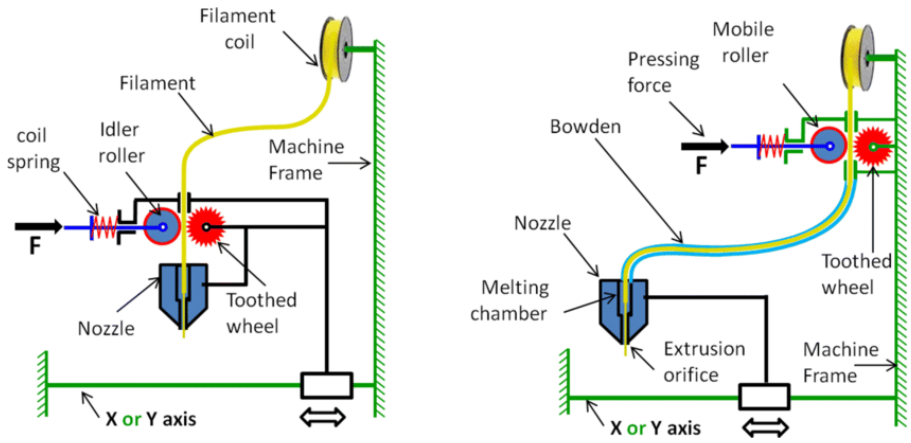
De massa van de thermistor is zo hoog dat het lang duurt om in evenwicht te komen met de luchttemperatuur. Daarom loopt de gemeenten temperatuur dus aanzienlijk achter op de werkelijke temperatuur. De werkelijke temperatuur is geverifieerd door een thermokoppel naast de thermistor te hangen.

4 Mogelijke oplossingen

4.1 Extruder problemen

Het probleem van een vastlopende extruder kwam voor met een direct drive extruder. Een oplossing die overwogen was, was het overstappen naar een andere extruder architectuur.

4.1.1 Verschillende soorten extruders



Figuur 4.1: Diagram van de twee soorten extruders die veel woorden gebruikt [1].

Bowden extruder

De rechter helft van Figuur 4.1 [1] is een diagram van een Bowden extruder. Hierbij is te zien dat extruder los is van de hotend.

Direct drive extruder

De linker helft van Figuur 4.1 [1] is een diagram van een direct drive extruder.

4.1.2 Zou een Bowden extruder de problemen oplossen

Met een bowden extruder zou het probleem van smeltend plastic in de extruder (Hoofdstuk 3.1) opgelost kunnen woorden. Echter was opgemerkt dat PP niet geprint kan woorden met een bowden printer (Hoofdstuk 3.2).

4.1.3 Zou een water gekoelde extruder de problemen oplossen

Een water gekoelde extruder/hotend zou allebei de problemen kunnen oplossen met als enige nadeel extra complexheid in de vorm van aanstuur elektronica en software voor de waterkoeling en de waterkoeling zelf (buizen, pomp, radiator).

Een goede optie zou de "Titan Aqua"[5] zijn.

4.2 Temperatuur overshoot

Een PID lus voor de kamertemperatuur kan woorden geïmplementeerd in de firmware van de printer, het vermogen van de warmte-elementen kan worden teruggedraaid om ervoor te zorgen dat de temperatuur minder snel stijgt en er dus een minder groot verschil is tussen de gemeenten en de werkelijke temperatuur.

5 De gekozen oplossing

Om een oplossing to kiezen is overlegt met het materiaal team, en de opdrachtgever.

5.1 Extruder

Voor de extruder is gekozen om de originele extruder er op te laten zitten, hier voor zijn 2 redenen:

- Er waren geen watergekoelde extruders beschikbaar met een levertijd voor het het eind van de stageperiode, echter word wel aanbevolen in de toekomst om een water gekoelde extruder te installeren. Dat is ook opgenomen in hoofdstuk 9.
- Tijdens testen is geconcludeerd dat met bepaalde instelling HDPE prima printbaar is. En zeker als een paar massa procent carbon fiber word toegevoegd.

5.2 Temperatuur overshoot

Een PID lus is geïmplementeerd in de firmware, en de autotune feature van Marlin is gebruikt om dezen te tunen.

6 Ontwerp van de oplossing en de benodigde onderdelen

6.1 Hardware

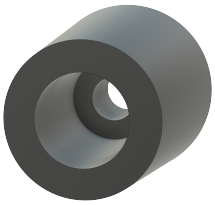
Het mechanisch ontwerp van de printer was grotendeels al gedaan, echter zijn er een aantal aanpassingen gedaan, die staan hier beschreven.

6.1.1 Ge-3D-printe oplossingen

Een aantal problemen zijn opgelost door kleine onderdelen te 3D-printen. hier zijn daar een paar voorbeelden van.

Voetjes van de printer

De voetjes van de printer waren te kort, dus daar zijn langere voor ontworpen en ge-3D-print. Zie Figuur 6.1 voor een render van het 3D ontwerp.



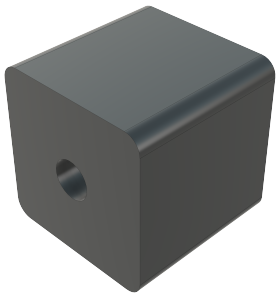
Figuur 6.1: Render van het 3D ontwerp van de voetjes van de printer

Afstandhouder

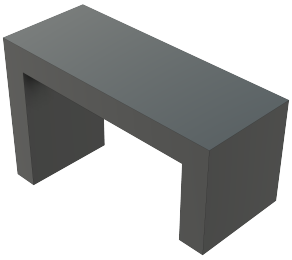
De originele printer is omgebouwd met roestvrijstalen panelen aan alle kanten. Om ervoor te zorgen dat er goede thermische isolatie is van de print kamer, is het een dubbelwandig ontwerp met glaswol er tussen. De dubbele wanden worden op afstand gehouden met ge-3D-printe afstandhouders. Zie Figuur 6.2 voor een render van het 3D ontwerp van deze afstandhouders.

Haakje

Om de deur dicht te houden is er een haakje geprint. Zie Figuur 6.3 voor een render van het 3D ontwerp van het haakje.



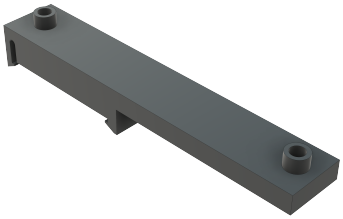
Figuur 6.2: Render van het 3D ontwerp van de afstandhouder van de printer



Figuur 6.3: Render van het 3D ontwerp van het haakje van de printer

DIN-rail bevestigingen

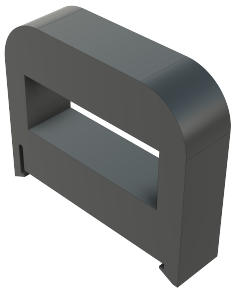
Op de zijkant van de printer was een DIN-rail bevestigd, hierop werd vervolgens alle elektronica bevestigd. In Figuur 6.4, 6.5 en 6.6 zijn de montage stukken te zien voor de PCB en de stroomtoevoer.



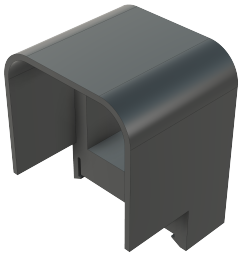
Figuur 6.4: Render van het 3D ontwerp van de DIN-rail PCB houder

6.2 Electronica

De te gebruiken elektronica was grotendeels al vastgesteld voor het project begon. Maar er was vrije keuze voor het hoofd board, hiervoor is een bigtreetech SKR-2 gekoozen [6]. Dit board was gekozen omdat deze vrij nieuw is, makkelijk te gebruiken, en veel mogelijkheden bied.



Figuur 6.5: Render van het 3D ontwerp van de schakelaar houder op de DIN-rail



Figuur 6.6: Render van het 3D ontwerp van het haakje van de C-14 houder op de DIN-rail

6.3 Software

Onder software word de slicer gezien. Er is gekozen voor prusaslicer, omdat dit een veel gebruikte slicer is die veel opties bied en gratis(open source) is.

De settings waarmee is getest zijn beschikbaar gesteld voor het team bij 3devo. Zodat zij verder kunnen werken aan de progressie die tijdens de stageperiode is verricht. Dit staat gedocumenteerd in de GitHub repo van het project.

6.4 Firmware

Voor de firmware is Marlin gekozen, en deze is geconfigureerd om te werken met de hardware (elektronica/stappenmotoren/sensoren) van de printer. Dit staat gedocumenteerd in de GitHub repo van het project.

7 Assemblage

7.1 Assemblage van de printer

Het mechanisch ontwerp van de printer was al vastgesteld, de printer hoefde dus alleen nog in elkaar woorden gezet. De printer is gebaseerd op de Ender-5, een robuuste printer die een goed platform bied om een geïsoleerde behuizing er omheen te bouwen. De printer is voorzien van dubbele laser gesnelde wanden met glas wol daar tussen. Ondank dat de assemblage van de behuizing niet in de scoop van het project valt, was het wal nodig om verder te gaan met het project. dus dat was als eerste gedaan.

7.1.1 Electronich

Electronich gezien moest er voral een hoop cable mangiment gebeuren. En de firmware moest op het bord woorden gezet.

7.2 firmware

De firmware die op het bord draait is een aangepaste versie van Marlin. Marlin is een open source 3D-printer firmware die uitermate geschikt is voor hobby FDM 3D-printers, vanwege de wereldwijde support van vrijwilligers die meehelpen aan het project [3]. De aanpassingen aan de firmware zijn gemaakt in het configuratiebestand, zie bijlagen H en I voor de configuratie.

8 Toetsing eindresultaat aan de hand van de eisen

8.1 Veiligheid

Er is rekening gehouden met de elektrische veiligheid, in figuur 6.6 is bijvoorbeeld te zien hoe een extra kapje is toegevoegd over de blote contacten van de C-14 stekker.

8.2 Eenvoudigheid

De printer is makkelijk te gebruiken aan de hande van de handlijding, zie bijlagen G.

8.3 Overig

De printer voldoet ook aan de andere eisen.

9 Conclusie en aanbevelingen

Uit dit verslag kan geconcludeerd woorden dat dit project geslaagd is omdat het product op tijd werd opgeleverd, en voldoet aan alle gestelden eisen.

Echter zijn er wel wat aandachtpunten, zoals dat de printqwalitijd niet voledig naar wens is, daarvoor is de aanbeveling aan 3devo om:

- Een gewater koelde extruder te installeren
- De printer beter te tunen om met gewenste kwaliteit te printen.

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Appendices

A Intervisie

Formulier HHS Elektrotechniek
Intervisie van Luca van Straaten (18073611) bij EFPC

Student over Intervisie bedrijf	
Naam bedrijf	**EFPC**
Vestigingsplaats	**De Bilt**
Bedrijfsbegeleider	**Ronald van brakel**
Naam student	**Menno Hondius**
Datum	**11-10-21**
Type bedrijfservaring	**○ eerste stage X tweede stage ○ afstuderen**

Omschrijving van de verrichtte werkzaamheden:

Inzicht verkrijgen in brand risico als gevolg van zonen installaties op fabriek daken. De installatie van zonnepanelen heeft een bepaald risicoprofiel waarbij elektriciteit een bepaalde rol heeft.

Omschrijving van de werkomgeving en/of de werksfeer:

Informeel, begeleider makkelijk aan te spreken. Altijd vragen om hulp en veel mensen met kennis om vragen aan te stellen.

Algemene indruk en/of bijzonderheden van de stage:

Er is een cursus ruimte waar sprinkler cursussen woorden georganiseerd.

B Student over docentbezoek

Formulier HHS Elektrotechniek

Student over docentbezoek	
Naam bedrijf	**3devo**
Vestigingsplaats	**Utrecht**
Bedrijfsbegeleider	**Jesse**
Naam student	**Luca van Straaten**
Naam docent	**Ad van der Bergh**
Datum	**29-9-21**
Type bedrijfservaring	**X eerste stage ○ tweede stage ○ afstuderen**

Besproken onderwerpen:

Wat 3devo doet als bedrijf?

Wat ik doe bij 3devo?

Waarom ik dat doe bij 3devo?

Wat de moeilijkheden zijn met mijn opdracht?

Aandachtspunten m.b.t. mijn p.v.a.

Gemaakte afspraken:

Ik ga mijn p.v.a. verbeteren en opsturen.

Conclusie van het bezoek:

Ik ben goed op weg en als er vragen zijn kan ik die altijd op de mail zetten.

C Bedrijf over student

Formulier stagebeoordeling Elektrotechniek

Naam Student	**Luca van Straaten**
Studentnummer	**18073611**
Stage 1 / 2	**1**
Shift 1 / 2 / 3 / 4	**1**
Bedrijf	**3devo**
Bedrijfsbegeleider	**Jesse van der Zouw**

Beoordeling door het bedrijf

	O	T	V	G	U	NVT
Inzicht in opdracht					x	
Nauwkeurigheid					x	
Inzet				x		
Initiatief				x		
Houding als werknemer				x		
Samenwerking met begeleider				x		
Samenwerking met collega's				x		
	O	T	V	G	U	NVT
Competentie Analyseren [2)]				x		
Competentie Ontwerpen[2)]				x		
Competentie Realiseren [1)]					x	
Competentie Managen[2)]			x			
Competentie Onderzoeken[2)]			x			
Competentie Professionaliseren [1)]				x		

	O	T	V	G	U
Totale beoordeling				X	

Student (voor gezien) — datum

Luca van Straaten	15/11/2021

Namens het bedrijf — datum

Jesse van der Zouw	**15/11/2021**	

O = onvoldoende; T = twijfelachtig; V = voldoende; G = goed; U = uitmuntend; NVT = Niet van toepassing

[1)] In de eerste stage van de student

[2)] In de tweede stage van de student

D Student over bedrijf

Formulier HHS Elektrotechniek

Student over bedrijf	
Naam bedrijf	**3Devo**
Vestigingsplaats	**utrecht**
Bedrijfsbegeleider	**Jesse van der Zouw**
Naam student	**Luca van Straaten**
Datum	**12-11-21**
Type bedrijfservaring	**x eerste stage ○ tweede stage ○ afstuderen**

Omschrijving van de verrichtte werkzaamheden:

Werken aan prototypen 3D-printer

Omschrijving van de werkomgeving en/of de werksfeer:

De werkomgeving bij 3devo is relaxed, er wordt van je verwacht dat je goed werk levert, maar er wordt absoluut niet gemicromanaged

Algemene indruk en/of bijzonderheden van de stage:

Ik heb nou samengewerkt met het materiaal team, en minder met mijn begeleider die elektronica ontwerp doet

E Verantwoording van de behaalde competenties

verantwoording van de behaalde competenties

Realiseren

- Ik heb de printer opgeleverd die voldoet aan de gestelde eisen.
- IK heb daarvoor de printer in elkaar moeten zetten, en sommige onderdelen zelf moeten produceren.
- Ik heb de printer getest met meerdere materialen.
- Ik heb een verslag opgeleverd met daarin documentatie van het realisatieproces.

Professionaliseren

- Ik ben zelfstandig te werk gegaan met het project.
- Ik ben flexibel geweest op kantoor, door een aantal extra taken op me te nemen.
- Ik heb al mijn beslissingen genomen met de ethiek daar achter in gedachten.
- Ik heb mijn collega's geholpen en geadviseerd met probleem waar zij tegen aan liepen.
- Ik heb de software voor interen communicatie binnen het bedrijf gebruikt, en daar zowel in het Nederlands als in het Engels op gecommuniceerd.

Ontwerpen

- Ik heb de elektronica gekozen die voldoet aan de gestelde eisen.
- In het verslag is het ontwerp beschreven.
- Het ontwerp is getest aan de hand van de eisen.
- Ik heb documentatie opgeleverd waarmee de opdrachtgever de printer kan gebruiken.

F KORTE BESCHRIJVING VAN DE BEDRIJFSORGANISATIE

korte beschrijving van de bedrijfsorganisatie

Het bedrijf zit heel gewoontjes in elkaar. er is een baas, hij stuurt een aantal medewerkers aan, die vervolgens ook een aantal medewerkers aansturen. Maar het is ook heel open, iedereen kan aan iedereen om hulp vraagen, en dat gebeurt ook regelmatig.

G OVERDRACHT DOCUMENT

Transfer document for the heated chamber 3D printer (solid-kinetic)

This document describes how the printer can used.

Parts of the printer

- **main bord**: BigTreeTech SKR 2
- **Hotend**: E3D Titan Aero 1,75 mm 24V
- **Printer platform**: Creality 3D Ender-5
- **Volume** *(X,Y,Z)*: 200x200x300 mm

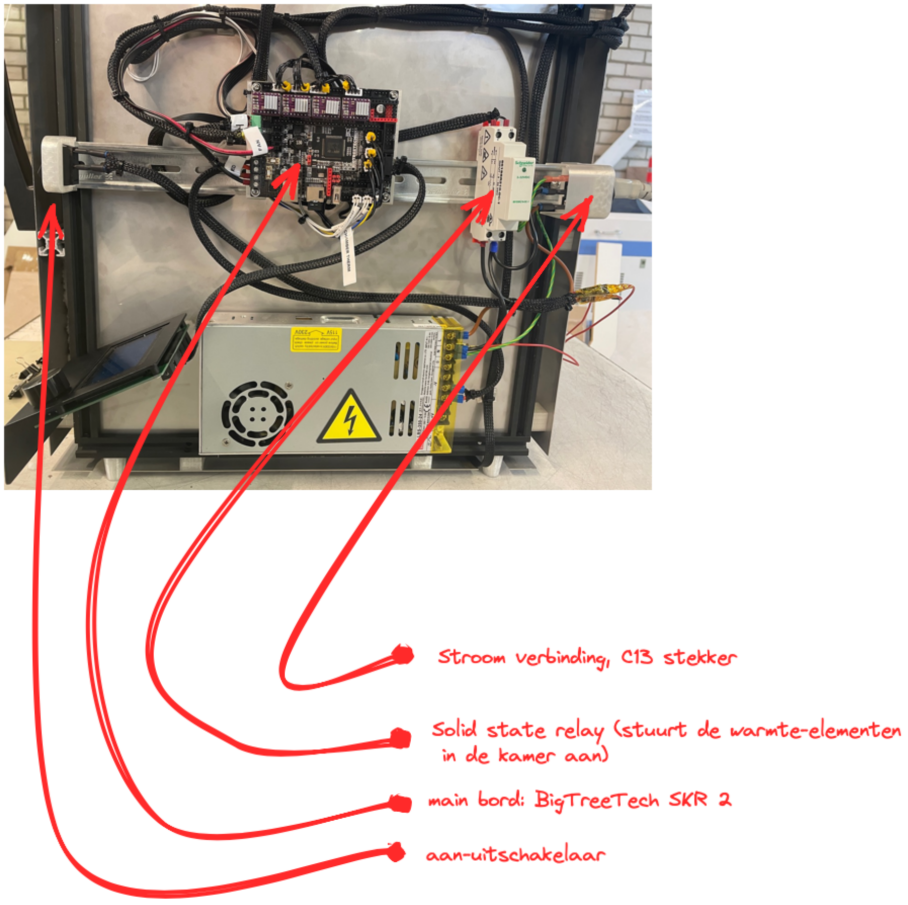

Figure 1: components

What do you have to do to use the printer?

1. Turn on the printer

Is the printer plugged in and the power switch turned on?

2. Slice:

Prusa slicer (or other Slic3r forks)

install: Install the settings files found on GitHub : `https://github.com/lucanatorvs/solid-kinetic` the settings files are in the folder: `slicer_settings/PrusaSliser` and there are also the installation instructions.

using the slicer: Instructions for the slicer are on the prusa3d website. `https://www.prusa3d.com/prusaslicer/`

setting up the slicer: The slicer has a number of settings that you can adjust. that is necessary to get good results. But the project defaults on github are good enough to start with.

To completely tune the printer and achieve the best results, you can use the tool by Teaching Tech `https://teachingtechyt.github.io/calibration.html`. Here is clearly documented what you can do to calibrate the printer.

export gcode: From the slicer, you can export the gcode to a micro-SD card. The printer prints directly from the SD card. If you have trouble connecting to the card, try turning the printer off and on, or try reformatting the SD-card to FAT32.

3. printing:

Print from the SD-card. Most print settings can be directly changed during the print from the display.

4. Bed (leveling):

The bed leveling procedure is the same as any other 3D printer. Or use the mesh leveling tool. The bed is coverd with PP tape, this can be scraped of and replaced when needed.

5. Filament:

The printer uses 1.75 mm filament. The spool needs to be suported above the printer and the filament needs to be fed through the hole on top of the printer en into the E3D Titan Aero extruder-hotend.

6 heated chamber:

The heated chamber can either be controlled from G-CODE or from the printer directly. The G-CODE comands are:

```
M141 S40  ; set chamber temp @ 40
M191 S40  ; wait for chamber temp @ 40
```

furure improvements

Add a water cooled hotend-extruder.

Figure 2: qrcode to the github repo

H Configuration

```
/**
 * Marlin 3D Printer Firmware
 * Copyright (c) 2020 MarlinFirmware [https://github.com/MarlinFirmware/Marlin]
 *
 * Based on Sprinter and grbl.
 * Copyright (c) 2011 Camiel Gubbels / Erik van der Zalm
 *
 * This program is free software: you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program.  If not, see <https://www.gnu.org/licenses/>.
 *
 */
#pragma once

/**
 * Configuration.h
 *
 * Basic settings such as:
 *
 * - Type of electronics
 * - Type of temperature sensor
 * - Printer geometry
 * - Endstop configuration
 * - LCD controller
 * - Extra features
 *
 * Advanced settings can be found in Configuration_adv.h
 */
#define CONFIGURATION_H_VERSION 02000902

//===========================================================================
//============================= Getting Started =============================
//===========================================================================

/**
 * Here are some useful links to help get your machine configured and calibrated:
 *
 * Example Configs: https://github.com/MarlinFirmware/Configurations/branches/all
 *
 * Průša Calculator:    https://blog.prusaprinters.org/calculator_3416/
 *
 * Calibration Guides:  https://reprap.org/wiki/Calibration
 *
```

```
https://reprap.org/wiki/Triffid_Hunter%27s_Calibration_Guide
 *
https://sites.google.com/site/repraplogphase/calibration-of-your-reprap
 *                      https://youtu.be/wAL9d7FgInk
 *
 * Calibration Objects: https://www.thingiverse.com/thing:5573
 *                      https://www.thingiverse.com/thing:1278865
 */

//===========================================================================
//============================ DELTA / SCARA / TPARA ============================
//===========================================================================
//
// Download configurations from the link above and customize for your machine.
// Examples are located in config/examples/delta, .../SCARA, and .../TPARA.
//
//===========================================================================

// @section info

// Author info of this build printed to the host during boot and M115
#define STRING_CONFIG_H_AUTHOR "(Lucanator, Io)" // Who made the changes.
//#define CUSTOM_VERSION_FILE Version.h // Path from the root directory (no quotes)

/**
 * *** VENDORS PLEASE READ ***
 *
 * Marlin allows you to add a custom boot image for Graphical LCDs.
 * With this option Marlin will first show your custom screen followed
 * by the standard Marlin logo with version number and web URL.
 *
 * We encourage you to take advantage of this new feature and we also
 * respectfully request that you retain the unmodified Marlin boot screen.
 */

// Show the Marlin bootscreen on startup. ** ENABLE FOR PRODUCTION **
// #define SHOW_BOOTSCREEN

// Show the bitmap in Marlin/_Bootscreen.h on startup.
// #define SHOW_CUSTOM_BOOTSCREEN

// Show the bitmap in Marlin/_Statusscreen.h on the status screen.
// #define CUSTOM_STATUS_SCREEN_IMAGE

// @section machine

/**
 * Select the serial port on the board to use for communication with the host.
 * This allows the connection of wireless adapters (for instance) to non-default port pins.
 * Serial port -1 is the USB emulated serial port, if available.
 * Note: The first serial port (-1 or 0) will always be used by the Arduino
```

```
 * Note: The first serial port (-1 or 0) will always be used by the Arduino
bootloader.
 *
 * :[-1, 0, 1, 2, 3, 4, 5, 6, 7]
 */
#define SERIAL_PORT 1

/**
 * Serial Port Baud Rate
 * This is the default communication speed for all serial ports.
 * Set the baud rate defaults for additional serial ports below.
 *
 * 250000 works in most cases, but you might try a lower speed if
 * you commonly experience drop-outs during host printing.
 * You may try up to 1000000 to speed up SD file transfer.
 *
 * :[2400, 9600, 19200, 38400, 57600, 115200, 250000, 500000, 1000000]
 */
#define BAUDRATE 115200
//#define BAUD_RATE_GCODE     // Enable G-code M575 to set the baud rate

/**
 * Select a secondary serial port on the board to use for communication with
the host.
 * Currently Ethernet (-2) is only supported on Teensy 4.1 boards.
 * :[-2, -1, 0, 1, 2, 3, 4, 5, 6, 7]
 */
#define SERIAL_PORT_2 -1
//#define BAUDRATE_2 250000   // Enable to override BAUDRATE

/**
 * Select a third serial port on the board to use for communication with the
host.
 * Currently only supported for AVR, DUE, LPC1768/9 and STM32/STM32F1
 * :[-1, 0, 1, 2, 3, 4, 5, 6, 7]
 */
#define SERIAL_PORT_3 3
//#define BAUDRATE_3 250000   // Enable to override BAUDRATE

// Enable the Bluetooth serial interface on AT90USB devices
//#define BLUETOOTH

// Choose the name from boards.h that matches your setup
#ifndef MOTHERBOARD
  #define MOTHERBOARD BOARD_BTT_SKR_V2_0_REV_B
#endif

// Name displayed in the LCD "Ready" message and Info menu
#define CUSTOM_MACHINE_NAME "3Devo"

// Printer's unique ID, used by some programs to differentiate between
machines.
// Choose your own or use a service like
https://www.uuidgenerator.net/version4
//#define MACHINE_UUID "f1448366-6e98-4b6f-bced-90fb6e24768f"

/**
 * Define the number of coordinated linear axes.
 * See https://github.com/DerAndere1/Marlin/wiki
```

```
 * Each linear axis gets its own stepper control and endstop:
 *
 *   Steppers: *_STEP_PIN, *_ENABLE_PIN, *_DIR_PIN, *_ENABLE_ON
 *   Endstops: *_STOP_PIN, USE_*MIN_PLUG, USE_*MAX_PLUG
 *       Axes: *_MIN_POS, *_MAX_POS, INVERT_*_DIR
 *    Planner: DEFAULT_AXIS_STEPS_PER_UNIT, DEFAULT_MAX_FEEDRATE
 *             DEFAULT_MAX_ACCELERATION, AXIS_RELATIVE_MODES,
 *             MICROSTEP_MODES, MANUAL_FEEDRATE
 *
 * :[3, 4, 5, 6]
 */
//#define LINEAR_AXES 3

/**
 * Axis codes for additional axes:
 * This defines the axis code that is used in G-code commands to
 * reference a specific axis.
 * 'A' for rotational axis parallel to X
 * 'B' for rotational axis parallel to Y
 * 'C' for rotational axis parallel to Z
 * 'U' for secondary linear axis parallel to X
 * 'V' for secondary linear axis parallel to Y
 * 'W' for secondary linear axis parallel to Z
 * Regardless of the settings, firmware-internal axis IDs are
 * I (AXIS4), J (AXIS5), K (AXIS6).
 */
#if LINEAR_AXES >= 4
  #define AXIS4_NAME 'A' // :['A', 'B', 'C', 'U', 'V', 'W']
#endif
#if LINEAR_AXES >= 5
  #define AXIS5_NAME 'B' // :['A', 'B', 'C', 'U', 'V', 'W']
#endif
#if LINEAR_AXES >= 6
  #define AXIS6_NAME 'C' // :['A', 'B', 'C', 'U', 'V', 'W']
#endif

// @section extruder

// This defines the number of extruders
// :[0, 1, 2, 3, 4, 5, 6, 7, 8]
#define EXTRUDERS 1

// Generally expected filament diameter (1.75, 2.85, 3.0, ...). Used for
Volumetric, Filament Width Sensor, etc.
#define DEFAULT_NOMINAL_FILAMENT_DIA 1.75

// For Cyclops or any "multi-extruder" that shares a single nozzle.
//#define SINGLENOZZLE

// Save and restore temperature and fan speed on tool-change.
// Set standby for the unselected tool with M104/106/109 T...
#if ENABLED(SINGLENOZZLE)
  //#define SINGLENOZZLE_STANDBY_TEMP
  //#define SINGLENOZZLE_STANDBY_FAN
#endif

/**
 * Multi-Material Unit
 * Set to one of these predefined models:
```

```
 * Set to one of these predefined models:
 *
 *   PRUSA_MMU1           : Průša MMU1 (The "multiplexer" version)
 *   PRUSA_MMU2           : Průša MMU2
 *   PRUSA_MMU2S          : Průša MMU2S (Requires MK3S extruder with motion sensor, EXTRUDERS = 5)
 *   EXTENDABLE_EMU_MMU2  : MMU with configurable number of filaments (ERCF, SMuFF or similar with Průša MMU2 compatible firmware)
 *   EXTENDABLE_EMU_MMU2S : MMUS with configurable number of filaments (ERCF, SMuFF or similar with Průša MMU2 compatible firmware)
 *
 * Requires NOZZLE_PARK_FEATURE to park print head in case MMU unit fails.
 * See additional options in Configuration_adv.h.
 */
//#define MMU_MODEL PRUSA_MMU2

// A dual extruder that uses a single stepper motor
//#define SWITCHING_EXTRUDER
#if ENABLED(SWITCHING_EXTRUDER)
  #define SWITCHING_EXTRUDER_SERVO_NR 0
  #define SWITCHING_EXTRUDER_SERVO_ANGLES { 0, 90 } // Angles for E0, E1[, E2, E3]
  #if EXTRUDERS > 3
    #define SWITCHING_EXTRUDER_E23_SERVO_NR 1
  #endif
#endif

// A dual-nozzle that uses a servomotor to raise/lower one (or both) of the nozzles
//#define SWITCHING_NOZZLE
#if ENABLED(SWITCHING_NOZZLE)
  #define SWITCHING_NOZZLE_SERVO_NR 0
  //#define SWITCHING_NOZZLE_E1_SERVO_NR 1          // If two servos are used, the index of the second
  #define SWITCHING_NOZZLE_SERVO_ANGLES { 0, 90 }   // Angles for E0, E1 (single servo) or lowered/raised (dual servo)
#endif

/**
 * Two separate X-carriages with extruders that connect to a moving part
 * via a solenoid docking mechanism. Requires SOL1_PIN and SOL2_PIN.
 */
//#define PARKING_EXTRUDER

/**
 * Two separate X-carriages with extruders that connect to a moving part
 * via a magnetic docking mechanism using movements and no solenoid
 *
 * project   : https://www.thingiverse.com/thing:3080893
 * movements : https://youtu.be/0xCEiG9VS3k
 *             https://youtu.be/Bqbcs0CU2FE
 */
//#define MAGNETIC_PARKING_EXTRUDER

#if EITHER(PARKING_EXTRUDER, MAGNETIC_PARKING_EXTRUDER)

  #define PARKING_EXTRUDER_PARKING_X { -78, 184 }     // X positions for parking the extruders
  #define PARKING_EXTRUDER_GRAB_DISTANCE 1            // (mm) Distance to
```

```
move beyond the parking point to grab the extruder
  //#define MANUAL_SOLENOID_CONTROL                  // Manual control of docking solenoids with M380 S / M381

  #if ENABLED(PARKING_EXTRUDER)

    #define PARKING_EXTRUDER_SOLENOIDS_INVERT          // If enabled, the solenoid is NOT magnetized with applied voltage
    #define PARKING_EXTRUDER_SOLENOIDS_PINS_ACTIVE LOW  // LOW or HIGH pin signal energizes the coil
    #define PARKING_EXTRUDER_SOLENOIDS_DELAY 250        // (ms) Delay for magnetic field. No delay if 0 or not defined.
    //#define MANUAL_SOLENOID_CONTROL                  // Manual control of docking solenoids with M380 S / M381

  #elif ENABLED(MAGNETIC_PARKING_EXTRUDER)

    #define MPE_FAST_SPEED      9000      // (mm/min) Speed for travel before last distance point
    #define MPE_SLOW_SPEED      4500      // (mm/min) Speed for last distance travel to park and couple
    #define MPE_TRAVEL_DISTANCE   10      // (mm) Last distance point
    #define MPE_COMPENSATION       0      // Offset Compensation -1 , 0 , 1 (multiplier) only for coupling

  #endif

#endif

/**
 * Switching Toolhead
 *
 * Support for swappable and dockable toolheads, such as
 * the E3D Tool Changer. Toolheads are locked with a servo.
 */
//#define SWITCHING_TOOLHEAD

/**
 * Magnetic Switching Toolhead
 *
 * Support swappable and dockable toolheads with a magnetic
 * docking mechanism using movement and no servo.
 */
//#define MAGNETIC_SWITCHING_TOOLHEAD

/**
 * Electromagnetic Switching Toolhead
 *
 * Parking for CoreXY / HBot kinematics.
 * Toolheads are parked at one edge and held with an electromagnet.
 * Supports more than 2 Toolheads. See https://youtu.be/JolbsAKTKf4
 */
//#define ELECTROMAGNETIC_SWITCHING_TOOLHEAD

#if ANY(SWITCHING_TOOLHEAD, MAGNETIC_SWITCHING_TOOLHEAD, ELECTROMAGNETIC_SWITCHING_TOOLHEAD)
  #define SWITCHING_TOOLHEAD_Y_POS          235         // (mm) Y position of the toolhead dock
  #define SWITCHING_TOOLHEAD_Y_SECURITY      10         // (mm) Security
```

```
  #define SWITCHING_TOOLHEAD_Y_SECURITY      10          // (mm) Security distance Y axis
  #define SWITCHING_TOOLHEAD_Y_CLEAR         60          // (mm) Minimum distance from dock for unobstructed X axis
  #define SWITCHING_TOOLHEAD_X_POS          { 215, 0 }  // (mm) X positions for parking the extruders
  #if ENABLED(SWITCHING_TOOLHEAD)
    #define SWITCHING_TOOLHEAD_SERVO_NR       2          // Index of the servo connector
    #define SWITCHING_TOOLHEAD_SERVO_ANGLES { 0, 180 }  // (degrees) Angles for Lock, Unlock
  #elif ENABLED(MAGNETIC_SWITCHING_TOOLHEAD)
    #define SWITCHING_TOOLHEAD_Y_RELEASE      5          // (mm) Security distance Y axis
    #define SWITCHING_TOOLHEAD_X_SECURITY   { 90, 150 } // (mm) Security distance X axis (T0,T1)
    //#define PRIME_BEFORE_REMOVE                       // Prime the nozzle before release from the dock
    #if ENABLED(PRIME_BEFORE_REMOVE)
      #define SWITCHING_TOOLHEAD_PRIME_MM           20  // (mm)   Extruder prime length
      #define SWITCHING_TOOLHEAD_RETRACT_MM         10  // (mm)   Retract after priming length
      #define SWITCHING_TOOLHEAD_PRIME_FEEDRATE    300  // (mm/min) Extruder prime feedrate
      #define SWITCHING_TOOLHEAD_RETRACT_FEEDRATE 2400  // (mm/min) Extruder retract feedrate
    #endif
  #elif ENABLED(ELECTROMAGNETIC_SWITCHING_TOOLHEAD)
    #define SWITCHING_TOOLHEAD_Z_HOP          2          // (mm) Z raise for switching
  #endif
#endif

/**
 * "Mixing Extruder"
 *   - Adds G-codes M163 and M164 to set and "commit" the current mix factors.
 *   - Extends the stepping routines to move multiple steppers in proportion to the mix.
 *   - Optional support for Repetier Firmware's 'M164 S<index>' supporting virtual tools.
 *   - This implementation supports up to two mixing extruders.
 *   - Enable DIRECT_MIXING_IN_G1 for M165 and mixing in G1 (from Pia Taubert's reference implementation).
 */
//#define MIXING_EXTRUDER
#if ENABLED(MIXING_EXTRUDER)
  #define MIXING_STEPPERS 2        // Number of steppers in your mixing extruder
  #define MIXING_VIRTUAL_TOOLS 16  // Use the Virtual Tool method with M163 and M164
  //#define DIRECT_MIXING_IN_G1    // Allow ABCDHI mix factors in G1 movement commands
  //#define GRADIENT_MIX           // Support for gradient mixing with M166 and LCD
  //#define MIXING_PRESETS         // Assign 8 default V-tool presets for 2 or 3 MIXING_STEPPERS
  #if ENABLED(GRADIENT_MIX)
```

```
    //#define GRADIENT_VTOOL       // Add M166 T to use a V-tool index as a Gradient alias
  #endif
#endif

// Offset of the extruders (uncomment if using more than one and relying on firmware to position when changing).
// The offset has to be X=0, Y=0 for the extruder 0 hotend (default extruder).
// For the other hotends it is their distance from the extruder 0 hotend.
//#define HOTEND_OFFSET_X { 0.0, 20.00 } // (mm) relative X-offset for each nozzle
//#define HOTEND_OFFSET_Y { 0.0, 5.00 }  // (mm) relative Y-offset for each nozzle
//#define HOTEND_OFFSET_Z { 0.0, 0.00 }  // (mm) relative Z-offset for each nozzle

// @section machine

/**
 * Power Supply Control
 *
 * Enable and connect the power supply to the PS_ON_PIN.
 * Specify whether the power supply is active HIGH or active LOW.
 */
//#define PSU_CONTROL
//#define PSU_NAME "Power Supply"

#if ENABLED(PSU_CONTROL)
  //#define MKS_PWC                 // Using the MKS PWC add-on
  //#define PS_OFF_CONFIRM          // Confirm dialog when power off
  //#define PS_OFF_SOUND            // Beep 1s when power off
  #define PSU_ACTIVE_STATE LOW      // Set 'LOW' for ATX, 'HIGH' for X-Box

  //#define PSU_DEFAULT_OFF         // Keep power off until enabled directly with M80
  //#define PSU_POWERUP_DELAY 250   // (ms) Delay for the PSU to warm up to full power

  //#define PSU_POWERUP_GCODE  "M355 S1"  // G-code to run after power-on (e.g., case light on)
  //#define PSU_POWEROFF_GCODE "M355 S0"  // G-code to run before power-off (e.g., case light off)

  //#define AUTO_POWER_CONTROL      // Enable automatic control of the PS_ON pin
  #if ENABLED(AUTO_POWER_CONTROL)
    #define AUTO_POWER_FANS         // Turn on PSU if fans need power
    #define AUTO_POWER_E_FANS
    #define AUTO_POWER_CONTROLLERFAN
    #define AUTO_POWER_CHAMBER_FAN
    #define AUTO_POWER_COOLER_FAN
    //#define AUTO_POWER_E_TEMP        50 // (°C) Turn on PSU if any extruder is over this temperature
    //#define AUTO_POWER_CHAMBER_TEMP  30 // (°C) Turn on PSU if the chamber is over this temperature
    //#define AUTO_POWER_COOLER_TEMP   26 // (°C) Turn on PSU if the cooler is over this temperature
    #define POWER_TIMEOUT               30 // (s) Turn off power if the
```

```
    #define POWER_TIMEOUT                30 // (s) Turn off power if the machine is idle for this duration
    //#define POWER_OFF_DELAY            60 // (s) Delay of poweroff after M81 command. Useful to let fans run for extra time.
  #endif
#endif

//===========================================================================
//============================= Thermal Settings ============================
//===========================================================================
// @section temperature

/**
 * --NORMAL IS 4.7kΩ PULLUP!-- 1kΩ pullup can be used on hotend sensor, using correct resistor and table
 *
 * Temperature sensors available:
 *
 *  SPI RTD/Thermocouple Boards - IMPORTANT: Read the NOTE below!
 *  -------
 *    -5 : MAX31865 with Pt100/Pt1000, 2, 3, or 4-wire  (only for sensors 0-1)
 *                  NOTE: You must uncomment/set the MAX31865_*_OHMS_n defines below.
 *    -3 : MAX31855 with Thermocouple, -200°C to +700°C (only for sensors 0-1)
 *    -2 : MAX6675  with Thermocouple, 0°C to +700°C    (only for sensors 0-1)
 *
 *  NOTE: Ensure TEMP_n_CS_PIN is set in your pins file for each TEMP_SENSOR_n using an SPI Thermocouple. By default,
 *        Hardware SPI on the default serial bus is used. If you have also set TEMP_n_SCK_PIN and TEMP_n_MISO_PIN,
 *        Software SPI will be used on those ports instead. You can force Hardware SPI on the default bus in the
 *        Configuration_adv.h file. At this time, separate Hardware SPI buses for sensors are not supported.
 *
 *  Analog Themocouple Boards
 *  -------
 *    -4 : AD8495 with Thermocouple
 *    -1 : AD595  with Thermocouple
 *
 *  Analog Thermistors - 4.7kΩ pullup - Normal
 *  -------
 *     1 : 100kΩ  EPCOS - Best choice for EPCOS thermistors
 *   331 : 100kΩ  Same as #1, but 3.3V scaled for MEGA
 *   332 : 100kΩ  Same as #1, but 3.3V scaled for DUE
 *     2 : 200kΩ  ATC Semitec 204GT-2
 *   202 : 200kΩ  Copymaster 3D
 *     3 : ???Ω   Mendel-parts thermistor
 *     4 : 10kΩ   Generic Thermistor !! DO NOT use for a hotend - it gives bad resolution at high temp. !!
 *     5 : 100kΩ  ATC Semitec 104GT-2/104NT-4-R025H42G - Used in ParCan, J-Head, and E3D, SliceEngineering 300°C
 *   501 : 100kΩ  Zonestar - Tronxy X3A
```

```
 *   502 : 100kΩ  Zonestar - used by hot bed in Zonestar Průša P802M
 *   512 : 100kΩ  RPW-Ultra hotend
 *     6 : 100kΩ  EPCOS - Not as accurate as table #1 (created using a fluke thermocouple)
 *     7 : 100kΩ  Honeywell 135-104LAG-J01
 *    71 : 100kΩ  Honeywell 135-104LAF-J01
 *     8 : 100kΩ  Vishay 0603 SMD NTCS0603E3104FXT
 *     9 : 100kΩ  GE Sensing AL03006-58.2K-97-G1
 *    10 : 100kΩ  RS PRO 198-961
 *    11 : 100kΩ  Keenovo AC silicone mats, most Wanhao i3 machines - beta 3950, 1%
 *    12 : 100kΩ  Vishay 0603 SMD NTCS0603E3104FXT (#8) - calibrated for Makibox hot bed
 *    13 : 100kΩ  Hisens up to 300°C - for "Simple ONE" & "All In ONE" hotend - beta 3950, 1%
 *    15 : 100kΩ  Calibrated for JGAurora A5 hotend
 *    18 : 200kΩ  ATC Semitec 204GT-2 Dagoma.Fr - MKS_Base_DKU001327
 *    22 : 100kΩ  GTM32 Pro vB - hotend - 4.7kΩ pullup to 3.3V and 220Ω to analog input
 *    23 : 100kΩ  GTM32 Pro vB - bed - 4.7kΩ pullup to 3.3v and 220Ω to analog input
 *    30 : 100kΩ  Kis3d Silicone heating mat 200W/300W with 6mm precision cast plate (EN AW 5083) NTC100K - beta 3950
 *    60 : 100kΩ  Maker's Tool Works Kapton Bed Thermistor - beta 3950
 *    61 : 100kΩ  Formbot/Vivedino 350°C Thermistor - beta 3950
 *    66 : 4.7MΩ  Dyze Design High Temperature Thermistor
 *    67 : 500kΩ  SliceEngineering 450°C Thermistor
 *    70 : 100kΩ  bq Hephestos 2
 *    75 : 100kΩ  Generic Silicon Heat Pad with NTC100K MGB18-104F39050L32
 *  2000 : 100kΩ  Ultimachine Rambo TDK NTCG104LH104KT1 NTC100K motherboard Thermistor
 *
 *  Analog Thermistors - 1kΩ pullup - Atypical, and requires changing out the 4.7kΩ pullup for 1kΩ.
 *  -------                          (but gives greater accuracy and more stable PID)
 *    51 : 100kΩ  EPCOS (1kΩ pullup)
 *    52 : 200kΩ  ATC Semitec 204GT-2 (1kΩ pullup)
 *    55 : 100kΩ  ATC Semitec 104GT-2 - Used in ParCan & J-Head (1kΩ pullup)
 *
 *  Analog Thermistors - 10kΩ pullup - Atypical
 *  -------
 *    99 : 100kΩ  Found on some Wanhao i3 machines with a 10kΩ pull-up resistor
 *
 *  Analog RTDs (Pt100/Pt1000)
 *  -------
 *   110 : Pt100  with 1kΩ pullup (atypical)
 *   147 : Pt100  with 4.7kΩ pullup
 *  1010 : Pt1000 with 1kΩ pullup (atypical)
 *  1047 : Pt1000 with 4.7kΩ pullup (E3D)
 *    20 : Pt100  with circuit in the Ultimainboard V2.x with mainboard ADC reference voltage = INA826 amplifier-board supply voltage.
 *                NOTE: (1) Must use an ADC input with no pullup. (2) Some INA826 amplifiers are unreliable at 3.3V so consider using sensor 147, 110, or 21.
 *    21 : Pt100  with circuit in the Ultimainboard V2.x with 3.3v ADC reference voltage (STM32, LPC176x....) and 5V INA826 amplifier board supply.
 *                NOTE: ADC pins are not 5V tolerant. Not recommended
```

```
 *                NOTE: ADC pins are not 5V tolerant. Not recommended because it's possible to damage the CPU by going over 500°C.
 *   201 : Pt100  with circuit in Overlord, similar to Ultimainboard V2.x
 *
 *  Custom/Dummy/Other Thermal Sensors
 *  ------
 *     0 : not used
 *  1000 : Custom - Specify parameters in Configuration_adv.h
 *
 *   !!! Use these for Testing or Development purposes. NEVER for production machine. !!!
 *   998 : Dummy Table that ALWAYS reads 25°C or the temperature defined below.
 *   999 : Dummy Table that ALWAYS reads 100°C or the temperature defined below.
 *
 */
#define TEMP_SENSOR_0 1
#define TEMP_SENSOR_1 0
#define TEMP_SENSOR_2 0
#define TEMP_SENSOR_3 0
#define TEMP_SENSOR_4 0
#define TEMP_SENSOR_5 0
#define TEMP_SENSOR_6 0
#define TEMP_SENSOR_7 0
#define TEMP_SENSOR_BED 1
#define TEMP_SENSOR_PROBE 0
#define TEMP_SENSOR_CHAMBER 4
#define TEMP_SENSOR_COOLER 0
#define TEMP_SENSOR_BOARD 0
#define TEMP_SENSOR_REDUNDANT 0

// Dummy thermistor constant temperature readings, for use with 998 and 999
#define DUMMY_THERMISTOR_998_VALUE  25
#define DUMMY_THERMISTOR_999_VALUE 100

// Resistor values when using MAX31865 sensors (-5) on TEMP_SENSOR_0 / 1
//#define MAX31865_SENSOR_OHMS_0      100   // (Ω) Typically 100 or 1000 (PT100 or PT1000)
//#define MAX31865_CALIBRATION_OHMS_0 430   // (Ω) Typically 430 for Adafruit PT100; 4300 for Adafruit PT1000
//#define MAX31865_SENSOR_OHMS_1      100
//#define MAX31865_CALIBRATION_OHMS_1 430

#define TEMP_RESIDENCY_TIME         10  // (seconds) Time to wait for hotend to "settle" in M109
#define TEMP_WINDOW                  1  // (°C) Temperature proximity for the "temperature reached" timer
#define TEMP_HYSTERESIS              3  // (°C) Temperature proximity considered "close enough" to the target

#define TEMP_BED_RESIDENCY_TIME     10  // (seconds) Time to wait for bed to "settle" in M190
#define TEMP_BED_WINDOW              1  // (°C) Temperature proximity for the "temperature reached" timer
#define TEMP_BED_HYSTERESIS          3  // (°C) Temperature proximity considered "close enough" to the target

#define TEMP_CHAMBER_RESIDENCY_TIME 10  // (seconds) Time to wait for
```

```
chamber to "settle" in M191
#define TEMP_CHAMBER_WINDOW          1  // (°C) Temperature proximity for the "temperature reached" timer
#define TEMP_CHAMBER_HYSTERESIS      3  // (°C) Temperature proximity considered "close enough" to the target

/**
 * Redundant Temperature Sensor (TEMP_SENSOR_REDUNDANT)
 *
 * Use a temp sensor as a redundant sensor for another reading. Select an unused temperature sensor, and another
 * sensor you'd like it to be redundant for. If the two thermistors differ by TEMP_SENSOR_REDUNDANT_MAX_DIFF (°C),
 * the print will be aborted. Whichever sensor is selected will have its normal functions disabled; i.e. selecting
 * the Bed sensor (-1) will disable bed heating/monitoring.
 *
 * For selecting source/target use: COOLER, PROBE, BOARD, CHAMBER, BED, E0, E1, E2, E3, E4, E5, E6, E7
 */
#if TEMP_SENSOR_REDUNDANT
  #define TEMP_SENSOR_REDUNDANT_SOURCE    E1  // The sensor that will provide the redundant reading.
  #define TEMP_SENSOR_REDUNDANT_TARGET    E0  // The sensor that we are providing a redundant reading for.
  #define TEMP_SENSOR_REDUNDANT_MAX_DIFF  10  // (°C) Temperature difference that will trigger a print abort.
#endif

// Below this temperature the heater will be switched off
// because it probably indicates a broken thermistor wire.
#define HEATER_0_MINTEMP   5
#define HEATER_1_MINTEMP   5
#define HEATER_2_MINTEMP   5
#define HEATER_3_MINTEMP   5
#define HEATER_4_MINTEMP   5
#define HEATER_5_MINTEMP   5
#define HEATER_6_MINTEMP   5
#define HEATER_7_MINTEMP   5
#define BED_MINTEMP        5
#define CHAMBER_MINTEMP    5

// Above this temperature the heater will be switched off.
// This can protect components from overheating, but NOT from shorts and failures.
// (Use MINTEMP for thermistor short/failure protection.)
#define HEATER_0_MAXTEMP 275
#define HEATER_1_MAXTEMP 275
#define HEATER_2_MAXTEMP 275
#define HEATER_3_MAXTEMP 275
#define HEATER_4_MAXTEMP 275
#define HEATER_5_MAXTEMP 275
#define HEATER_6_MAXTEMP 275
#define HEATER_7_MAXTEMP 275
#define BED_MAXTEMP      170
#define CHAMBER_MAXTEMP  170

/**
 * Thermal Overshoot
```

```
 * Thermal Overshoot
 * During heatup (and printing) the temperature can often "overshoot" the target by many degrees
 * (especially before PID tuning). Setting the target temperature too close to MAXTEMP guarantees
 * a MAXTEMP shutdown! Use these values to forbid temperatures being set too close to MAXTEMP.
 */
#define HOTEND_OVERSHOOT 15   // (°C) Forbid temperatures over MAXTEMP - OVERSHOOT
#define BED_OVERSHOOT    10   // (°C) Forbid temperatures over MAXTEMP - OVERSHOOT
#define COOLER_OVERSHOOT  2   // (°C) Forbid temperatures closer than OVERSHOOT

//===========================================================================
//============================= PID Settings ================================
//===========================================================================
// PID Tuning Guide here: https://reprap.org/wiki/PID_Tuning

// Comment the following line to disable PID and enable bang-bang.
#define PIDTEMP
#define BANG_MAX 255     // Limits current to nozzle while in bang-bang mode; 255=full current
#define PID_MAX BANG_MAX // Limits current to nozzle while PID is active (see PID_FUNCTIONAL_RANGE below); 255=full current
#define PID_K1 0.95      // Smoothing factor within any PID loop

#if ENABLED(PIDTEMP)
  //#define PID_EDIT_MENU         // Add PID editing to the "Advanced Settings" menu. (~700 bytes of PROGMEM)
  //#define PID_AUTOTUNE_MENU     // Add PID auto-tuning to the "Advanced Settings" menu. (~250 bytes of PROGMEM)
  //#define PID_PARAMS_PER_HOTEND // Uses separate PID parameters for each extruder (useful for mismatched extruders)
                                  // Set/get with gcode: M301 E[extruder number, 0-2]

  #if ENABLED(PID_PARAMS_PER_HOTEND)
    // Specify up to one value per hotend here, according to your setup.
    // If there are fewer values, the last one applies to the remaining hotends.
    #define DEFAULT_Kp_LIST {  22.20,  22.20 }
    #define DEFAULT_Ki_LIST {   1.08,   1.08 }
    #define DEFAULT_Kd_LIST { 114.00, 114.00 }
  #else
    #define DEFAULT_Kp  30.73
    #define DEFAULT_Ki   2.61
    #define DEFAULT_Kd  90.34
  #endif
#endif // PIDTEMP

//===========================================================================
//===================== PID > Bed Temperature Control =======================
```

```
612 //===========================================================================
613
614 /**
615  * PID Bed Heating
616  *
617  * If this option is enabled set PID constants below.
618  * If this option is disabled, bang-bang will be used and BED_LIMIT_SWITCHING will enable hysteresis.
619  *
620  * The PID frequency will be the same as the extruder PWM.
621  * If PID_dT is the default, and correct for the hardware/configuration, that means 7.689Hz,
622  * which is fine for driving a square wave into a resistive load and does not significantly
623  * impact FET heating. This also works fine on a Fotek SSR-10DA Solid State Relay into a 250W
624  * heater. If your configuration is significantly different than this and you don't understand
625  * the issues involved, don't use bed PID until someone else verifies that your hardware works.
626  */
627 //#define PIDTEMPBED
628
629 //#define BED_LIMIT_SWITCHING
630
631 /**
632  * Max Bed Power
633  * Applies to all forms of bed control (PID, bang-bang, and bang-bang with hysteresis).
634  * When set to any value below 255, enables a form of PWM to the bed that acts like a divider
635  * so don't use it unless you are OK with PWM on your bed. (See the comment on enabling PIDTEMPBED)
636  */
637 #define MAX_BED_POWER 255 // limits duty cycle to bed; 255=full current
638
639 #if ENABLED(PIDTEMPBED)
640   //#define MIN_BED_POWER 0
641   //#define PID_BED_DEBUG // Sends debug data to the serial port.
642
643   // 120V 250W silicone heater into 4mm borosilicate (MendelMax 1.5+)
644   // from FOPDT model - kp=.39 Tp=405 Tdead=66, Tc set to 79.2, aggressive factor of .15 (vs .1, 1, 10)
645   #define DEFAULT_bedKp 10.00
646   #define DEFAULT_bedKi .023
647   #define DEFAULT_bedKd 305.4
648
649   // FIND YOUR OWN: "M303 E-1 C8 S90" to run autotune on the bed at 90 degreesC for 8 cycles.
650 #endif // PIDTEMPBED
651
652 //===========================================================================
653 //==================== PID > Chamber Temperature Control ====================
654 //===========================================================================
```

```
/**
 * PID Chamber Heating
 *
 * If this option is enabled set PID constants below.
 * If this option is disabled, bang-bang will be used and CHAMBER_LIMIT_SWITCHING will enable
 * hysteresis.SOFT_PWM_SCALE
 *
 * The PID frequency will be the same as the extruder PWM.
 * If PID_dT is the default, and correct for the hardware/configuration, that means 7.689Hz,
 * which is fine for driving a square wave into a resistive load and does not significantly
 * impact FET heating. This also works fine on a Fotek SSR-10DA Solid State Relay into a 200W
 * heater. If your configuration is significantly different than this and you don't understand
 * the issues involved, don't use chamber PID until someone else verifies that your hardware works.
 */
#define PIDTEMPCHAMBER
// #define CHAMBER_LIMIT_SWITCHING

/**
 * Max Chamber Power
 * Applies to all forms of chamber control (PID, bang-bang, and bang-bang with hysteresis).
 * When set to any value below 255, enables a form of PWM to the chamber heater that acts like a divider
 * so don't use it unless you are OK with PWM on your heater. (See the comment on enabling PIDTEMPCHAMBER)
 */
#define MAX_CHAMBER_POWER 255 // limits duty cycle to chamber heater; 255=full current

#if ENABLED(PIDTEMPCHAMBER)
  #define MIN_CHAMBER_POWER 0
  //#define PID_CHAMBER_DEBUG // Sends debug data to the serial port.

  // Lasko "MyHeat Personal Heater" (200w) modified with a Fotek SSR-10DA to control only the heating element
  // and placed inside the small Creality printer enclosure tent.
  //
  #define DEFAULT_chamberKp 37.04
  #define DEFAULT_chamberKi 1.40
  #define DEFAULT_chamberKd 655.17
  // M309 P37.04 I1.04 D655.17

  // FIND YOUR OWN: "M303 E-2 C8 S50" to run autotune on the chamber at 50 degreesC for 8 cycles.
#endif // PIDTEMPCHAMBER

#if ANY(PIDTEMP, PIDTEMPBED, PIDTEMPCHAMBER)
  //#define PID_DEBUG             // Sends debug data to the serial port. Use 'M303 D' to toggle activation.
  //#define PID_OPENLOOP          // Puts PID in open loop. M104/M140 sets the output power from 0 to PID_MAX
  //#define SLOW_PWM_HEATERS      // PWM with very low frequency (roughly
```

```
0.125Hz=8s) and minimum state time of approximately 1s useful for heaters
driven by a relay
  #define PID_FUNCTIONAL_RANGE 10 // If the temperature difference between
the target temperature and the actual temperature
                                  // is more than PID_FUNCTIONAL_RANGE then
the PID will be shut off and the heater will be set to min/max.
#endif

// @section extruder

/**
 * Prevent extrusion if the temperature is below EXTRUDE_MINTEMP.
 * Add M302 to set the minimum extrusion temperature and/or turn
 * cold extrusion prevention on and off.
 *
 * *** IT IS HIGHLY RECOMMENDED TO LEAVE THIS OPTION ENABLED! ***
 */
#define PREVENT_COLD_EXTRUSION
#define EXTRUDE_MINTEMP 140

/**
 * Prevent a single extrusion longer than EXTRUDE_MAXLENGTH.
 * Note: For Bowden Extruders make this large enough to allow load/unload.
 */
#define PREVENT_LENGTHY_EXTRUDE
#define EXTRUDE_MAXLENGTH 200

//===========================================================================
=
//========================= Thermal Runaway Protection
=======================
//===========================================================================
=

/**
 * Thermal Protection provides additional protection to your printer from
damage
 * and fire. Marlin always includes safe min and max temperature ranges
which
 * protect against a broken or disconnected thermistor wire.
 *
 * The issue: If a thermistor falls out, it will report the much lower
 * temperature of the air in the room, and the the firmware will keep
 * the heater on.
 *
 * If you get "Thermal Runaway" or "Heating failed" errors the
 * details can be tuned in Configuration_adv.h
 */

#define THERMAL_PROTECTION_HOTENDS // Enable thermal protection for all
extruders
#define THERMAL_PROTECTION_BED     // Enable thermal protection for the
heated bed
#define THERMAL_PROTECTION_CHAMBER // Enable thermal protection for the
heated chamber
#define THERMAL_PROTECTION_COOLER  // Enable thermal protection for the
laser cooling

//
```

```
//===========================================================================
//============================ Mechanical Settings ==========================
//===========================================================================

// @section machine

// Enable one of the options below for CoreXY, CoreXZ, or CoreYZ kinematics,
// either in the usual order or reversed
//#define COREXY
//#define COREXZ
//#define COREYZ
//#define COREYX
//#define COREZX
//#define COREZY
//#define MARKFORGED_XY  // MarkForged. See https://reprap.org/forum/read.php?152,504042

// Enable for a belt style printer with endless "Z" motion
//#define BELTPRINTER

// Enable for Polargraph Kinematics
//#define POLARGRAPH
#if ENABLED(POLARGRAPH)
  #define POLARGRAPH_MAX_BELT_LEN 1035.0
  #define POLAR_SEGMENTS_PER_SECOND 5
#endif

//===========================================================================
//============================= Endstop Settings ============================
//===========================================================================

// @section homing

// Specify here all the endstop connectors that are connected to any endstop or probe.
// Almost all printers will be using one per axis. Probes will use one or more of the
// extra connectors. Leave undefined any used for non-endstop and non-probe purposes.
//#define USE_XMIN_PLUG
//#define USE_YMIN_PLUG
#define USE_ZMIN_PLUG
//#define USE_IMIN_PLUG
//#define USE_JMIN_PLUG
//#define USE_KMIN_PLUG
#define USE_XMAX_PLUG
#define USE_YMAX_PLUG
//#define USE_ZMAX_PLUG
//#define USE_IMAX_PLUG
//#define USE_JMAX_PLUG
//#define USE_KMAX_PLUG

// Enable pullup for all endstops to prevent a floating state
```

```
#define ENDSTOPPULLUPS
#if DISABLED(ENDSTOPPULLUPS)
  // Disable ENDSTOPPULLUPS to set pullups individually
  //#define ENDSTOPPULLUP_XMAX
  //#define ENDSTOPPULLUP_YMAX
  //#define ENDSTOPPULLUP_ZMAX
  //#define ENDSTOPPULLUP_IMAX
  //#define ENDSTOPPULLUP_JMAX
  //#define ENDSTOPPULLUP_KMAX
  //#define ENDSTOPPULLUP_XMIN
  //#define ENDSTOPPULLUP_YMIN
  //#define ENDSTOPPULLUP_ZMIN
  //#define ENDSTOPPULLUP_IMIN
  //#define ENDSTOPPULLUP_JMIN
  //#define ENDSTOPPULLUP_KMIN
  //#define ENDSTOPPULLUP_ZMIN_PROBE
#endif

// Enable pulldown for all endstops to prevent a floating state
//#define ENDSTOPPULLDOWNS
#if DISABLED(ENDSTOPPULLDOWNS)
  // Disable ENDSTOPPULLDOWNS to set pulldowns individually
  //#define ENDSTOPPULLDOWN_XMAX
  //#define ENDSTOPPULLDOWN_YMAX
  //#define ENDSTOPPULLDOWN_ZMAX
  //#define ENDSTOPPULLDOWN_IMAX
  //#define ENDSTOPPULLDOWN_JMAX
  //#define ENDSTOPPULLDOWN_KMAX
  //#define ENDSTOPPULLDOWN_XMIN
  //#define ENDSTOPPULLDOWN_YMIN
  //#define ENDSTOPPULLDOWN_ZMIN
  //#define ENDSTOPPULLDOWN_IMIN
  //#define ENDSTOPPULLDOWN_JMIN
  //#define ENDSTOPPULLDOWN_KMIN
  //#define ENDSTOPPULLDOWN_ZMIN_PROBE
#endif

// Mechanical endstop with COM to ground and NC to Signal uses "false" here
(most common setup).
#define X_MIN_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define Y_MIN_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define Z_MIN_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define I_MIN_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define J_MIN_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define K_MIN_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define X_MAX_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define Y_MAX_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define Z_MAX_ENDSTOP_INVERTING false // Set to true to invert the logic of
the endstop.
#define I_MAX_ENDSTOP_INVERTING false // Set to true to invert the logic of
```

```
the endstop.
#define J_MAX_ENDSTOP_INVERTING false // Set to true to invert the logic of the endstop.
#define K_MAX_ENDSTOP_INVERTING false // Set to true to invert the logic of the endstop.
#define Z_MIN_PROBE_ENDSTOP_INVERTING false // Set to true to invert the logic of the probe.

/**
 * Stepper Drivers
 *
 * These settings allow Marlin to tune stepper driver timing and enable advanced options for
 * stepper drivers that support them. You may also override timing options in Configuration_adv.h.
 *
 * A4988 is assumed for unspecified drivers.
 *
 * Use TMC2208/TMC2208_STANDALONE for TMC2225 drivers and TMC2209/TMC2209_STANDALONE for TMC2226 drivers.
 *
 * Options: A4988, A5984, DRV8825, LV8729, L6470, L6474, POWERSTEP01,
 *          TB6560, TB6600, TMC2100,
 *          TMC2130, TMC2130_STANDALONE, TMC2160, TMC2160_STANDALONE,
 *          TMC2208, TMC2208_STANDALONE, TMC2209, TMC2209_STANDALONE,
 *          TMC26X,  TMC26X_STANDALONE,  TMC2660, TMC2660_STANDALONE,
 *          TMC5130, TMC5130_STANDALONE, TMC5160, TMC5160_STANDALONE
 * :['A4988', 'A5984', 'DRV8825', 'LV8729', 'L6470', 'L6474', 'POWERSTEP01', 'TB6560', 'TB6600', 'TMC2100', 'TMC2130', 'TMC2130_STANDALONE', 'TMC2160', 'TMC2160_STANDALONE', 'TMC2208', 'TMC2208_STANDALONE', 'TMC2209', 'TMC2209_STANDALONE', 'TMC26X', 'TMC26X_STANDALONE', 'TMC2660', 'TMC2660_STANDALONE', 'TMC5130', 'TMC5130_STANDALONE', 'TMC5160', 'TMC5160_STANDALONE']
 */
#define X_DRIVER_TYPE  DRV8825
#define Y_DRIVER_TYPE  DRV8825
#define Z_DRIVER_TYPE  DRV8825
//#define X2_DRIVER_TYPE A4988
//#define Y2_DRIVER_TYPE A4988
//#define Z2_DRIVER_TYPE A4988
//#define Z3_DRIVER_TYPE A4988
//#define Z4_DRIVER_TYPE A4988
//#define I_DRIVER_TYPE  A4988
//#define J_DRIVER_TYPE  A4988
//#define K_DRIVER_TYPE  A4988
#define E0_DRIVER_TYPE DRV8825
//#define E1_DRIVER_TYPE A4988
//#define E2_DRIVER_TYPE A4988
//#define E3_DRIVER_TYPE A4988
//#define E4_DRIVER_TYPE A4988
//#define E5_DRIVER_TYPE A4988
//#define E6_DRIVER_TYPE A4988
//#define E7_DRIVER_TYPE A4988

// Enable this feature if all enabled endstop pins are interrupt-capable.
// This will remove the need to poll the interrupt pins, saving many CPU cycles.
//#define ENDSTOP_INTERRUPTS_FEATURE

```

```
/**
 * Endstop Noise Threshold
 *
 * Enable if your probe or endstops falsely trigger due to noise.
 *
 * - Higher values may affect repeatability or accuracy of some bed probes.
 * - To fix noise install a 100nF ceramic capacitor in parallel with the switch.
 * - This feature is not required for common micro-switches mounted on PCBs
 *   based on the Makerbot design, which already have the 100nF capacitor.
 *
 * :[2,3,4,5,6,7]
 */
//#define ENDSTOP_NOISE_THRESHOLD 2

// Check for stuck or disconnected endstops during homing moves.
//#define DETECT_BROKEN_ENDSTOP

//===========================================================================
//============================= Movement Settings ===========================
//===========================================================================
// @section motion

/**
 * Default Settings
 *
 * These settings can be reset by M502
 *
 * Note that if EEPROM is enabled, saved values will override these.
 */

/**
 * With this option each E stepper can have its own factors for the
 * following movement settings. If fewer factors are given than the
 * total number of extruders, the last value applies to the rest.
 */
//#define DISTINCT_E_FACTORS

/**
 * Default Axis Steps Per Unit (steps/mm)
 * Override with M92
 *                                      X, Y, Z [, I [, J [, K]]], E0 [, E1[, E2...]]
 */
#define DEFAULT_AXIS_STEPS_PER_UNIT   { 160, 160, 1600, 829.23 }

/**
 * Default Max Feed Rate (mm/s)
 * Override with M203
 *                                      X, Y, Z [, I [, J [, K]]], E0 [, E1[, E2...]]
 */
#define DEFAULT_MAX_FEEDRATE          { 500, 500, 50, 25 }

//#define LIMITED_MAX_FR_EDITING        // Limit edit via M203 or LCD to
```

```
DEFAULT_MAX_FEEDRATE * 2
#if ENABLED(LIMITED_MAX_FR_EDITING)
  #define MAX_FEEDRATE_EDIT_VALUES    { 600, 600, 10, 50 } // ...or, set your own edit limits
#endif

/**
 * Default Max Acceleration (change/s) change = mm/s
 * (Maximum start speed for accelerated moves)
 * Override with M201
 *                                       X, Y, Z [, I [, J [, K]]], E0 [, E1[, E2...]]
 */
#define DEFAULT_MAX_ACCELERATION      { 500, 500, 100, 5000 }

//#define LIMITED_MAX_ACCEL_EDITING     // Limit edit via M201 or LCD to DEFAULT_MAX_ACCELERATION * 2
#if ENABLED(LIMITED_MAX_ACCEL_EDITING)
  #define MAX_ACCEL_EDIT_VALUES       { 6000, 6000, 200, 20000 } // ...or, set your own edit limits
#endif

/**
 * Default Acceleration (change/s) change = mm/s
 * Override with M204
 *
 *   M204 P    Acceleration
 *   M204 R    Retract Acceleration
 *   M204 T    Travel Acceleration
 */
#define DEFAULT_ACCELERATION          500    // X, Y, Z and E acceleration for printing moves
#define DEFAULT_RETRACT_ACCELERATION  500    // E acceleration for retracts
#define DEFAULT_TRAVEL_ACCELERATION   500    // X, Y, Z acceleration for travel (non printing) moves

/**
 * Default Jerk limits (mm/s)
 * Override with M205 X Y Z E
 *
 * "Jerk" specifies the minimum speed change that requires acceleration.
 * When changing speed and direction, if the difference is less than the
 * value set here, it may happen instantaneously.
 */
//#define CLASSIC_JERK
#if ENABLED(CLASSIC_JERK)
  #define DEFAULT_XJERK 10.0
  #define DEFAULT_YJERK 10.0
  #define DEFAULT_ZJERK  0.3
  //#define DEFAULT_IJERK  0.3
  //#define DEFAULT_JJERK  0.3
  //#define DEFAULT_KJERK  0.3

  //#define TRAVEL_EXTRA_XYJERK 0.0     // Additional jerk allowance for all travel moves

  //#define LIMITED_JERK_EDITING        // Limit edit via M205 or LCD to DEFAULT_aJERK * 2
  #if ENABLED(LIMITED_JERK_EDITING)
```

```
    #define MAX_JERK_EDIT_VALUES { 20, 20, 0.6, 10 } // ...or, set your own edit limits
  #endif
#endif

#define DEFAULT_EJERK    5.0  // May be used by Linear Advance

/**
 * Junction Deviation Factor
 *
 * See:
 *   https://reprap.org/forum/read.php?1,739819
 *   https://blog.kyneticcnc.com/2018/10/computing-junction-deviation-for-marlin.html
 */
#if DISABLED(CLASSIC_JERK)
  #define JUNCTION_DEVIATION_MM 0.013 // (mm) Distance from real junction edge
  #define JD_HANDLE_SMALL_SEGMENTS    // Use curvature estimation instead of just the junction angle
                                      // for small segments (< 1mm) with large junction angles (> 135°).
#endif

/**
 * S-Curve Acceleration
 *
 * This option eliminates vibration during printing by fitting a Bézier
 * curve to move acceleration, producing much smoother direction changes.
 *
 * See https://github.com/synthetos/TinyG/wiki/Jerk-Controlled-Motion-Explained
 */
//#define S_CURVE_ACCELERATION

//===========================================================================
//============================= Z Probe Options =============================
//===========================================================================
// @section probes

//
// See https://marlinfw.org/docs/configuration/probes.html
//

/**
 * Enable this option for a probe connected to the Z-MIN pin.
 * The probe replaces the Z-MIN endstop and is used for Z homing.
 * (Automatically enables USE_PROBE_FOR_Z_HOMING.)
 */
//#define Z_MIN_PROBE_USES_Z_MIN_ENDSTOP_PIN

// Force the use of the probe for Z-axis homing
//#define USE_PROBE_FOR_Z_HOMING

/**
```

```
 * Z_MIN_PROBE_PIN
 *
 * Define this pin if the probe is not connected to Z_MIN_PIN.
 * If not defined the default pin for the selected MOTHERBOARD
 * will be used. Most of the time the default is what you want.
 *
 *  - The simplest option is to use a free endstop connector.
 *  - Use 5V for powered (usually inductive) sensors.
 *
 *  - RAMPS 1.3/1.4 boards may use the 5V, GND, and Aux4->D32 pin:
 *    - For simple switches connect...
 *      - normally-closed switches to GND and D32.
 *      - normally-open switches to 5V and D32.
 */
//#define Z_MIN_PROBE_PIN 32 // Pin 32 is the RAMPS default

/**
 * Probe Type
 *
 * Allen Key Probes, Servo Probes, Z-Sled Probes, FIX_MOUNTED_PROBE, etc.
 * Activate one of these to use Auto Bed Leveling below.
 */

/**
 * The "Manual Probe" provides a means to do "Auto" Bed Leveling without a probe.
 * Use G29 repeatedly, adjusting the Z height at each point with movement commands
 * or (with LCD_BED_LEVELING) the LCD controller.
 */
//#define PROBE_MANUALLY

/**
 * A Fix-Mounted Probe either doesn't deploy or needs manual deployment.
 *   (e.g., an inductive probe or a nozzle-based probe-switch.)
 */
//#define FIX_MOUNTED_PROBE

/**
 * Use the nozzle as the probe, as with a conductive
 * nozzle system or a piezo-electric smart effector.
 */
//#define NOZZLE_AS_PROBE

/**
 * Z Servo Probe, such as an endstop switch on a rotating arm.
 */
//#define Z_PROBE_SERVO_NR 0       // Defaults to SERVO 0 connector.
//#define Z_SERVO_ANGLES { 70, 0 } // Z Servo Deploy and Stow angles

/**
 * The BLTouch probe uses a Hall effect sensor and emulates a servo.
 */
//#define BLTOUCH

/**
 * Touch-MI Probe by hotends.fr
 *
 * This probe is deployed and activated by moving the X-axis to a magnet at
```

```
 * This probe is deployed and activated by moving the X-axis to a magnet at the edge of the bed.
 * By default, the magnet is assumed to be on the left and activated by a home. If the magnet is
 * on the right, enable and set TOUCH_MI_DEPLOY_XPOS to the deploy position.
 *
 * Also requires: BABYSTEPPING, BABYSTEP_ZPROBE_OFFSET, Z_SAFE_HOMING,
 *                and a minimum Z_HOMING_HEIGHT of 10.
 */
//#define TOUCH_MI_PROBE
#if ENABLED(TOUCH_MI_PROBE)
  #define TOUCH_MI_RETRACT_Z 0.5                // Height at which the probe retracts
  //#define TOUCH_MI_DEPLOY_XPOS (X_MAX_BED + 2)  // For a magnet on the right side of the bed
  //#define TOUCH_MI_MANUAL_DEPLOY              // For manual deploy (LCD menu)
#endif

// A probe that is deployed and stowed with a solenoid pin (SOL1_PIN)
//#define SOLENOID_PROBE

// A sled-mounted probe like those designed by Charles Bell.
//#define Z_PROBE_SLED
//#define SLED_DOCKING_OFFSET 5  // The extra distance the X axis must travel to pickup the sled. 0 should be fine but you can push it further if you'd like.

// A probe deployed by moving the x-axis, such as the Wilson II's rack-and-pinion probe designed by Marty Rice.
//#define RACK_AND_PINION_PROBE
#if ENABLED(RACK_AND_PINION_PROBE)
  #define Z_PROBE_DEPLOY_X  X_MIN_POS
  #define Z_PROBE_RETRACT_X X_MAX_POS
#endif

// Duet Smart Effector (for delta printers) - https://bit.ly/2ul5U7J
// When the pin is defined you can use M672 to set/reset the probe sensitivity.
//#define DUET_SMART_EFFECTOR
#if ENABLED(DUET_SMART_EFFECTOR)
  #define SMART_EFFECTOR_MOD_PIN  -1  // Connect a GPIO pin to the Smart Effector MOD pin
#endif

/**
 * Use StallGuard2 to probe the bed with the nozzle.
 * Requires stallGuard-capable Trinamic stepper drivers.
 * CAUTION: This can damage machines with Z lead screws.
 *          Take extreme care when setting up this feature.
 */
//#define SENSORLESS_PROBING

//
// For Z_PROBE_ALLEN_KEY see the Delta example configurations.
//

/**
 * Nozzle-to-Probe offsets { X, Y, Z }
```

```
 *
 * X and Y offset
 *   Use a caliper or ruler to measure the distance from the tip of
 *   the Nozzle to the center-point of the Probe in the X and Y axes.
 *
 * Z offset
 * - For the Z offset use your best known value and adjust at runtime.
 * - Common probes trigger below the nozzle and have negative values for Z offset.
 * - Probes triggering above the nozzle height are uncommon but do exist. When using
 *   probes such as this, carefully set Z_CLEARANCE_DEPLOY_PROBE and Z_CLEARANCE_BETWEEN_PROBES
 *   to avoid collisions during probing.
 *
 * Tune and Adjust
 * -  Probe Offsets can be tuned at runtime with 'M851', LCD menus, babystepping, etc.
 * -  PROBE_OFFSET_WIZARD (configuration_adv.h) can be used for setting the Z offset.
 *
 * Assuming the typical work area orientation:
 *  - Probe to RIGHT of the Nozzle has a Positive X offset
 *  - Probe to LEFT  of the Nozzle has a Negative X offset
 *  - Probe in BACK  of the Nozzle has a Positive Y offset
 *  - Probe in FRONT of the Nozzle has a Negative Y offset
 *
 * Some examples:
 *   #define NOZZLE_TO_PROBE_OFFSET { 10, 10, -1 }   // Example "1"
 *   #define NOZZLE_TO_PROBE_OFFSET {-10,  5, -1 }   // Example "2"
 *   #define NOZZLE_TO_PROBE_OFFSET {  5, -5, -1 }   // Example "3"
 *   #define NOZZLE_TO_PROBE_OFFSET {-15,-10, -1 }   // Example "4"
 *
 *     +-- BACK ---+
 *     |    [+]    |
 *   L |        1  | R <-- Example "1" (right+,  back+)
 *   E |  2        | I <-- Example "2" ( left-,  back+)
 *   F |[-]  N  [+]| G <-- Nozzle
 *   T |       3   | H <-- Example "3" (right+, front-)
 *     | 4         | T <-- Example "4" ( left-, front-)
 *     |    [-]    |
 *     O-- FRONT --+
 */
#define NOZZLE_TO_PROBE_OFFSET { 10, 10, 0 }

// Most probes should stay away from the edges of the bed, but
// with NOZZLE_AS_PROBE this can be negative for a wider probing area.
#define PROBING_MARGIN 10

// X and Y axis travel speed (mm/min) between probes
#define XY_PROBE_FEEDRATE (133*60)

// Feedrate (mm/min) for the first approach when double-probing (MULTIPLE_PROBING == 2)
#define Z_PROBE_FEEDRATE_FAST (4*60)

// Feedrate (mm/min) for the "accurate" probe of each point
#define Z_PROBE_FEEDRATE_SLOW (Z_PROBE_FEEDRATE_FAST / 2)
```

```
/**
 * Probe Activation Switch
 * A switch indicating proper deployment, or an optical
 * switch triggered when the carriage is near the bed.
 */
//#define PROBE_ACTIVATION_SWITCH
#if ENABLED(PROBE_ACTIVATION_SWITCH)
  #define PROBE_ACTIVATION_SWITCH_STATE LOW // State indicating probe is active
  //#define PROBE_ACTIVATION_SWITCH_PIN PC6 // Override default pin
#endif

/**
 * Tare Probe (determine zero-point) prior to each probe.
 * Useful for a strain gauge or piezo sensor that needs to factor out
 * elements such as cables pulling on the carriage.
 */
//#define PROBE_TARE
#if ENABLED(PROBE_TARE)
  #define PROBE_TARE_TIME  200    // (ms) Time to hold tare pin
  #define PROBE_TARE_DELAY 200    // (ms) Delay after tare before
  #define PROBE_TARE_STATE HIGH   // State to write pin for tare
  //#define PROBE_TARE_PIN PA5    // Override default pin
  #if ENABLED(PROBE_ACTIVATION_SWITCH)
    //#define PROBE_TARE_ONLY_WHILE_INACTIVE  // Fail to tare/probe if PROBE_ACTIVATION_SWITCH is active
  #endif
#endif

/**
 * Multiple Probing
 *
 * You may get improved results by probing 2 or more times.
 * With EXTRA_PROBING the more atypical reading(s) will be disregarded.
 *
 * A total of 2 does fast/slow probes with a weighted average.
 * A total of 3 or more adds more slow probes, taking the average.
 */
//#define MULTIPLE_PROBING 2
//#define EXTRA_PROBING    1

/**
 * Z probes require clearance when deploying, stowing, and moving between
 * probe points to avoid hitting the bed and other hardware.
 * Servo-mounted probes require extra space for the arm to rotate.
 * Inductive probes need space to keep from triggering early.
 *
 * Use these settings to specify the distance (mm) to raise the probe (or
 * lower the bed). The values set here apply over and above any (negative)
 * probe Z Offset set with NOZZLE_TO_PROBE_OFFSET, M851, or the LCD.
 * Only integer values >= 1 are valid here.
 *
 * Example: `M851 Z-5` with a CLEARANCE of 4  =>  9mm from bed to nozzle.
 *     But: `M851 Z+1` with a CLEARANCE of 2  =>  2mm from bed to nozzle.
 */
#define Z_CLEARANCE_DEPLOY_PROBE   10 // Z Clearance for Deploy/Stow
#define Z_CLEARANCE_BETWEEN_PROBES  5 // Z Clearance between probe points
#define Z_CLEARANCE_MULTI_PROBE     5 // Z Clearance between multiple probes
```

```
//#define Z_AFTER_PROBING          5 // Z position after probing is done

#define Z_PROBE_LOW_POINT          -2 // Farthest distance below the trigger-point to go before stopping

// For M851 give a range for adjusting the Z probe offset
#define Z_PROBE_OFFSET_RANGE_MIN -20
#define Z_PROBE_OFFSET_RANGE_MAX 20

// Enable the M48 repeatability test to test probe accuracy
//#define Z_MIN_PROBE_REPEATABILITY_TEST

// Before deploy/stow pause for user confirmation
//#define PAUSE_BEFORE_DEPLOY_STOW
#if ENABLED(PAUSE_BEFORE_DEPLOY_STOW)
  //#define PAUSE_PROBE_DEPLOY_WHEN_TRIGGERED // For Manual Deploy Allenkey Probe
#endif

/**
 * Enable one or more of the following if probing seems unreliable.
 * Heaters and/or fans can be disabled during probing to minimize electrical
 * noise. A delay can also be added to allow noise and vibration to settle.
 * These options are most useful for the BLTouch probe, but may also improve
 * readings with inductive probes and piezo sensors.
 */
//#define PROBING_HEATERS_OFF       // Turn heaters off when probing
#if ENABLED(PROBING_HEATERS_OFF)
  //#define WAIT_FOR_BED_HEATER     // Wait for bed to heat back up between probes (to improve accuracy)
  //#define WAIT_FOR_HOTEND         // Wait for hotend to heat back up between probes (to improve accuracy & prevent cold extrude)
#endif
//#define PROBING_FANS_OFF          // Turn fans off when probing
//#define PROBING_ESTEPPERS_OFF     // Turn all extruder steppers off when probing
//#define PROBING_STEPPERS_OFF      // Turn all steppers off (unless needed to hold position) when probing (including extruders)
//#define DELAY_BEFORE_PROBING 200  // (ms) To prevent vibrations from triggering piezo sensors

// Require minimum nozzle and/or bed temperature for probing
//#define PREHEAT_BEFORE_PROBING
#if ENABLED(PREHEAT_BEFORE_PROBING)
  #define PROBING_NOZZLE_TEMP 120   // (°C) Only applies to E0 at this time
  #define PROBING_BED_TEMP     50
#endif

// For Inverting Stepper Enable Pins (Active Low) use 0, Non Inverting (Active High) use 1
// :{ 0:'Low', 1:'High' }
#define X_ENABLE_ON 0
#define Y_ENABLE_ON 0
#define Z_ENABLE_ON 0
#define E_ENABLE_ON 0 // For all extruders
//#define I_ENABLE_ON 0
//#define J_ENABLE_ON 0
//#define K_ENABLE_ON 0
```

```
// Disable axis steppers immediately when they're not being stepped.
// WARNING: When motors turn off there is a chance of losing position accuracy!
#define DISABLE_X false
#define DISABLE_Y false
#define DISABLE_Z false
//#define DISABLE_I false
//#define DISABLE_J false
//#define DISABLE_K false

// Turn off the display blinking that warns about possible accuracy reduction
//#define DISABLE_REDUCED_ACCURACY_WARNING

// @section extruder

#define DISABLE_E false             // Disable the extruder when not stepping
#define DISABLE_INACTIVE_EXTRUDER   // Keep only the active extruder enabled

// @section machine

// Invert the stepper direction. Change (or reverse the motor connector) if an axis goes the wrong way.
#define INVERT_X_DIR false
#define INVERT_Y_DIR false
#define INVERT_Z_DIR false
//#define INVERT_I_DIR false
//#define INVERT_J_DIR false
//#define INVERT_K_DIR false

// @section extruder

// For direct drive extruder v9 set to true, for geared extruder set to false.
#define INVERT_E0_DIR true
#define INVERT_E1_DIR false
#define INVERT_E2_DIR false
#define INVERT_E3_DIR false
#define INVERT_E4_DIR false
#define INVERT_E5_DIR false
#define INVERT_E6_DIR false
#define INVERT_E7_DIR false

// @section homing

//#define NO_MOTION_BEFORE_HOMING // Inhibit movement until all axes have been homed. Also enable HOME_AFTER_DEACTIVATE for extra safety.
//#define HOME_AFTER_DEACTIVATE   // Require rehoming after steppers are deactivated. Also enable NO_MOTION_BEFORE_HOMING for extra safety.

/**
 * Set Z_IDLE_HEIGHT if the Z-Axis moves on its own when steppers are disabled.
 *  - Use a low value (i.e., Z_MIN_POS) if the nozzle falls down to the bed.
 *  - Use a large value (i.e., Z_MAX_POS) if the bed falls down, away from the nozzle.
 */
```

```
//#define Z_IDLE_HEIGHT Z_HOME_POS

//#define Z_HOMING_HEIGHT  4      // (mm) Minimal Z height before homing (G28) for Z clearance above the bed, clamps, ...
                                  // Be sure to have this much clearance over your Z_MAX_POS to prevent grinding.

//#define Z_AFTER_HOMING  10      // (mm) Height to move to after homing Z

// Direction of endstops when homing; 1=MAX, -1=MIN
// :[-1,1]
#define X_HOME_DIR 1
#define Y_HOME_DIR 1
#define Z_HOME_DIR -1
//#define I_HOME_DIR -1
//#define J_HOME_DIR -1
//#define K_HOME_DIR -1

// @section machine

// The size of the printable area
#define X_BED_SIZE 230
#define Y_BED_SIZE 225

// Travel limits (mm) after homing, corresponding to endstop positions.
#define X_MIN_POS 0
#define Y_MIN_POS 0
#define Z_MIN_POS 0
#define X_MAX_POS X_BED_SIZE
#define Y_MAX_POS Y_BED_SIZE
#define Z_MAX_POS 300
//#define I_MIN_POS 0
//#define I_MAX_POS 50
//#define J_MIN_POS 0
//#define J_MAX_POS 50
//#define K_MIN_POS 0
//#define K_MAX_POS 50

/**
 * Software Endstops
 *
 * - Prevent moves outside the set machine bounds.
 * - Individual axes can be disabled, if desired.
 * - X and Y only apply to Cartesian robots.
 * - Use 'M211' to set software endstops on/off or report current state
 */

// Min software endstops constrain movement within minimum coordinate bounds
#define MIN_SOFTWARE_ENDSTOPS
#if ENABLED(MIN_SOFTWARE_ENDSTOPS)
  #define MIN_SOFTWARE_ENDSTOP_X
  #define MIN_SOFTWARE_ENDSTOP_Y
  #define MIN_SOFTWARE_ENDSTOP_Z
  #define MIN_SOFTWARE_ENDSTOP_I
  #define MIN_SOFTWARE_ENDSTOP_J
  #define MIN_SOFTWARE_ENDSTOP_K
#endif

// Max software endstops constrain movement within maximum coordinate bounds
```

```
// Max software endstops constrain movement within maximum coordinate bounds
#define MAX_SOFTWARE_ENDSTOPS
#if ENABLED(MAX_SOFTWARE_ENDSTOPS)
  #define MAX_SOFTWARE_ENDSTOP_X
  #define MAX_SOFTWARE_ENDSTOP_Y
  #define MAX_SOFTWARE_ENDSTOP_Z
  #define MAX_SOFTWARE_ENDSTOP_I
  #define MAX_SOFTWARE_ENDSTOP_J
  #define MAX_SOFTWARE_ENDSTOP_K
#endif

#if EITHER(MIN_SOFTWARE_ENDSTOPS, MAX_SOFTWARE_ENDSTOPS)
  //#define SOFT_ENDSTOPS_MENU_ITEM  // Enable/Disable software endstops from the LCD
#endif

/**
 * Filament Runout Sensors
 * Mechanical or opto endstops are used to check for the presence of filament.
 *
 * IMPORTANT: Runout will only trigger if Marlin is aware that a print job is running.
 * Marlin knows a print job is running when:
 *  1. Running a print job from media started with M24.
 *  2. The Print Job Timer has been started with M75.
 *  3. The heaters were turned on and PRINTJOB_TIMER_AUTOSTART is enabled.
 *
 * RAMPS-based boards use SERVO3_PIN for the first runout sensor.
 * For other boards you may need to define FIL_RUNOUT_PIN, FIL_RUNOUT2_PIN, etc.
 */
//#define FILAMENT_RUNOUT_SENSOR
#if ENABLED(FILAMENT_RUNOUT_SENSOR)
  #define FIL_RUNOUT_ENABLED_DEFAULT true // Enable the sensor on startup. Override with M412 followed by M500.
  #define NUM_RUNOUT_SENSORS   1          // Number of sensors, up to one per extruder. Define a FIL_RUNOUT#_PIN for each.

  #define FIL_RUNOUT_STATE     LOW        // Pin state indicating that filament is NOT present.
  #define FIL_RUNOUT_PULLUP               // Use internal pullup for filament runout pins.
  //#define FIL_RUNOUT_PULLDOWN           // Use internal pulldown for filament runout pins.
  //#define WATCH_ALL_RUNOUT_SENSORS      // Execute runout script on any triggering sensor, not only for the active extruder.
                                          // This is automatically enabled for MIXING_EXTRUDERs.

  // Override individually if the runout sensors vary
  //#define FIL_RUNOUT1_STATE LOW
  //#define FIL_RUNOUT1_PULLUP
  //#define FIL_RUNOUT1_PULLDOWN

  //#define FIL_RUNOUT2_STATE LOW
  //#define FIL_RUNOUT2_PULLUP
  //#define FIL_RUNOUT2_PULLDOWN
```

```
  //#define FIL_RUNOUT3_STATE LOW
  //#define FIL_RUNOUT3_PULLUP
  //#define FIL_RUNOUT3_PULLDOWN

  //#define FIL_RUNOUT4_STATE LOW
  //#define FIL_RUNOUT4_PULLUP
  //#define FIL_RUNOUT4_PULLDOWN

  //#define FIL_RUNOUT5_STATE LOW
  //#define FIL_RUNOUT5_PULLUP
  //#define FIL_RUNOUT5_PULLDOWN

  //#define FIL_RUNOUT6_STATE LOW
  //#define FIL_RUNOUT6_PULLUP
  //#define FIL_RUNOUT6_PULLDOWN

  //#define FIL_RUNOUT7_STATE LOW
  //#define FIL_RUNOUT7_PULLUP
  //#define FIL_RUNOUT7_PULLDOWN

  //#define FIL_RUNOUT8_STATE LOW
  //#define FIL_RUNOUT8_PULLUP
  //#define FIL_RUNOUT8_PULLDOWN

  // Commands to execute on filament runout.
  // With multiple runout sensors use the %c placeholder for the current tool in commands (e.g., "M600 T%c")
  // NOTE: After 'M412 H1' the host handles filament runout and this script does not apply.
  #define FILAMENT_RUNOUT_SCRIPT "M600"

  // After a runout is detected, continue printing this length of filament
  // before executing the runout script. Useful for a sensor at the end of
  // a feed tube. Requires 4 bytes SRAM per sensor, plus 4 bytes overhead.
  //#define FILAMENT_RUNOUT_DISTANCE_MM 25

  #ifdef FILAMENT_RUNOUT_DISTANCE_MM
    // Enable this option to use an encoder disc that toggles the runout pin
    // as the filament moves. (Be sure to set FILAMENT_RUNOUT_DISTANCE_MM
    // large enough to avoid false positives.)
    //#define FILAMENT_MOTION_SENSOR
  #endif
#endif

//===========================================================================
//============================= Bed Leveling ============================
//===========================================================================
// @section calibrate

/**
 * Choose one of the options below to enable G29 Bed Leveling. The parameters
 * and behavior of G29 will change depending on your selection.
 *
 *  If using a Probe for Z Homing, enable Z_SAFE_HOMING also!
 *
```

```
 *
 * - AUTO_BED_LEVELING_3POINT
 *   Probe 3 arbitrary points on the bed (that aren't collinear)
 *   You specify the XY coordinates of all 3 points.
 *   The result is a single tilted plane. Best for a flat bed.
 *
 * - AUTO_BED_LEVELING_LINEAR
 *   Probe several points in a grid.
 *   You specify the rectangle and the density of sample points.
 *   The result is a single tilted plane. Best for a flat bed.
 *
 * - AUTO_BED_LEVELING_BILINEAR
 *   Probe several points in a grid.
 *   You specify the rectangle and the density of sample points.
 *   The result is a mesh, best for large or uneven beds.
 *
 * - AUTO_BED_LEVELING_UBL (Unified Bed Leveling)
 *   A comprehensive bed leveling system combining the features and benefits
 *   of other systems. UBL also includes integrated Mesh Generation, Mesh
 *   Validation and Mesh Editing systems.
 *
 * - MESH_BED_LEVELING
 *   Probe a grid manually
 *   The result is a mesh, suitable for large or uneven beds. (See
BILINEAR.)
 *   For machines without a probe, Mesh Bed Leveling provides a method to
perform
 *   leveling in steps so you can manually adjust the Z height at each grid-
point.
 *   With an LCD controller the process is guided step-by-step.
 */
//#define AUTO_BED_LEVELING_3POINT
//#define AUTO_BED_LEVELING_LINEAR
//#define AUTO_BED_LEVELING_BILINEAR
//#define AUTO_BED_LEVELING_UBL
#define MESH_BED_LEVELING

/**
 * Normally G28 leaves leveling disabled on completion. Enable one of
 * these options to restore the prior leveling state or to always enable
 * leveling immediately after G28.
 */
//#define RESTORE_LEVELING_AFTER_G28
//#define ENABLE_LEVELING_AFTER_G28

/**
 * Auto-leveling needs preheating
 */
//#define PREHEAT_BEFORE_LEVELING
#if ENABLED(PREHEAT_BEFORE_LEVELING)
  #define LEVELING_NOZZLE_TEMP 120   // (°C) Only applies to E0 at this time
  #define LEVELING_BED_TEMP     50
#endif

/**
 * Enable detailed logging of G28, G29, M48, etc.
 * Turn on with the command 'M111 S32'.
 * NOTE: Requires a lot of PROGMEM!
 */
```

```
//#define DEBUG_LEVELING_FEATURE

#if ANY(MESH_BED_LEVELING, AUTO_BED_LEVELING_UBL, PROBE_MANUALLY)
  // Set a height for the start of manual adjustment
  #define MANUAL_PROBE_START_Z 1  // (mm) Comment out to use the last-measured height
#endif

#if ANY(MESH_BED_LEVELING, AUTO_BED_LEVELING_BILINEAR, AUTO_BED_LEVELING_UBL)
  // Gradually reduce leveling correction until a set height is reached,
  // at which point movement will be level to the machine's XY plane.
  // The height can be set with M420 Z<height>
  #define ENABLE_LEVELING_FADE_HEIGHT
  #if ENABLED(ENABLE_LEVELING_FADE_HEIGHT)
    #define DEFAULT_LEVELING_FADE_HEIGHT 10.0 // (mm) Default fade height.
  #endif

  // For Cartesian machines, instead of dividing moves on mesh boundaries,
  // split up moves into short segments like a Delta. This follows the
  // contours of the bed more closely than edge-to-edge straight moves.
  #define SEGMENT_LEVELED_MOVES
  #define LEVELED_SEGMENT_LENGTH 5.0 // (mm) Length of all segments (except the last one)

  /**
   * Enable the G26 Mesh Validation Pattern tool.
   */
  //#define G26_MESH_VALIDATION
  #if ENABLED(G26_MESH_VALIDATION)
    #define MESH_TEST_NOZZLE_SIZE    0.4  // (mm) Diameter of primary nozzle.
    #define MESH_TEST_LAYER_HEIGHT   0.2  // (mm) Default layer height for G26.
    #define MESH_TEST_HOTEND_TEMP  205    // (°C) Default nozzle temperature for G26.
    #define MESH_TEST_BED_TEMP      60    // (°C) Default bed temperature for G26.
    #define G26_XY_FEEDRATE         20    // (mm/s) Feedrate for G26 XY moves.
    #define G26_XY_FEEDRATE_TRAVEL 100    // (mm/s) Feedrate for G26 XY travel moves.
    #define G26_RETRACT_MULTIPLIER   1.0  // G26 Q (retraction) used by default between mesh test elements.
  #endif

#endif

#if EITHER(AUTO_BED_LEVELING_LINEAR, AUTO_BED_LEVELING_BILINEAR)

  // Set the number of grid points per dimension.
  #define GRID_MAX_POINTS_X 3
  #define GRID_MAX_POINTS_Y GRID_MAX_POINTS_X

  // Probe along the Y axis, advancing X after each column
  //#define PROBE_Y_FIRST

  #if ENABLED(AUTO_BED_LEVELING_BILINEAR)
```

```
    // Beyond the probed grid, continue the implied tilt?
    // Default is to maintain the height of the nearest edge.
    //#define EXTRAPOLATE_BEYOND_GRID

    //
    // Experimental Subdivision of the grid by Catmull-Rom method.
    // Synthesizes intermediate points to produce a more detailed mesh.
    //
    //#define ABL_BILINEAR_SUBDIVISION
    #if ENABLED(ABL_BILINEAR_SUBDIVISION)
      // Number of subdivisions between probe points
      #define BILINEAR_SUBDIVISIONS 3
    #endif

  #endif

#elif ENABLED(AUTO_BED_LEVELING_UBL)

  //===========================================================================
  //========================= Unified Bed Leveling ============================
  //===========================================================================

  //#define MESH_EDIT_GFX_OVERLAY   // Display a graphics overlay while editing the mesh

  #define MESH_INSET 1              // Set Mesh bounds as an inset region of the bed
  #define GRID_MAX_POINTS_X 10      // Don't use more than 15 points per axis, implementation limited.
  #define GRID_MAX_POINTS_Y GRID_MAX_POINTS_X

  //#define UBL_HILBERT_CURVE       // Use Hilbert distribution for less travel when probing multiple points

  #define UBL_MESH_EDIT_MOVES_Z     // Sophisticated users prefer no movement of nozzle
  #define UBL_SAVE_ACTIVE_ON_M500   // Save the currently active mesh in the current slot on M500

  //#define UBL_Z_RAISE_WHEN_OFF_MESH 2.5 // When the nozzle is off the mesh, this value is used
                                          // as the Z-Height correction value.

  //#define UBL_MESH_WIZARD         // Run several commands in a row to get a complete mesh

#elif ENABLED(MESH_BED_LEVELING)

  //===========================================================================
  //=================================== Mesh ==================================
  //===========================================================================
```

```
1657
1658    #define MESH_INSET 20          // Set Mesh bounds as an inset region of the bed
1659    #define GRID_MAX_POINTS_X 3    // Don't use more than 7 points per axis, implementation limited.
1660    #define GRID_MAX_POINTS_Y GRID_MAX_POINTS_X
1661
1662    //#define MESH_G28_REST_ORIGIN // After homing all axes ('G28' or 'G28 XYZ') rest Z at Z_MIN_POS
1663
1664  #endif // BED_LEVELING
1665
1666  /**
1667   * Add a bed leveling sub-menu for ABL or MBL.
1668   * Include a guided procedure if manual probing is enabled.
1669   */
1670  #define LCD_BED_LEVELING
1671
1672  #if ENABLED(LCD_BED_LEVELING)
1673    #define MESH_EDIT_Z_STEP  0.025 // (mm) Step size while manually probing Z axis.
1674    #define LCD_PROBE_Z_RANGE 4     // (mm) Z Range centered on Z_MIN_POS for LCD Z adjustment
1675    #define MESH_EDIT_MENU        // Add a menu to edit mesh points
1676  #endif
1677
1678  // Add a menu item to move between bed corners for manual bed adjustment
1679  #define LEVEL_BED_CORNERS
1680
1681  #if ENABLED(LEVEL_BED_CORNERS)
1682    #define LEVEL_CORNERS_INSET_LFRB { 30, 30, 30, 30 } // (mm) Left, Front, Right, Back insets
1683    #define LEVEL_CORNERS_HEIGHT      0.0   // (mm) Z height of nozzle at leveling points
1684    #define LEVEL_CORNERS_Z_HOP       4.0   // (mm) Z height of nozzle between leveling points
1685    //#define LEVEL_CENTER_TOO              // Move to the center after the last corner
1686    //#define LEVEL_CORNERS_USE_PROBE
1687    #if ENABLED(LEVEL_CORNERS_USE_PROBE)
1688      #define LEVEL_CORNERS_PROBE_TOLERANCE 0.1
1689      #define LEVEL_CORNERS_VERIFY_RAISED   // After adjustment triggers the probe, re-probe to verify
1690      //#define LEVEL_CORNERS_AUDIO_FEEDBACK
1691    #endif
1692
1693    /**
1694     * Corner Leveling Order
1695     *
1696     * Set 2 or 4 points. When 2 points are given, the 3rd is the center of the opposite edge.
1697     *
1698     *  LF  Left-Front    RF  Right-Front
1699     *  LB  Left-Back     RB  Right-Back
1700     *
1701     * Examples:
1702     *
1703     *      Default        {LF,RB,LB,RF}         {LF,RF}           {LB,LF}
```

```
   *  LB --------- RB   LB --------- RB    LB --------- RB   LB --------- RB
   *  |  4       3  |   | 3         2 |    |     <3>     |   | 1           |
   *  |             |   |             |    |             |   |         <3>|
   *  |  1       2  |   | 1         4 |    | 1         2 |   | 2           |
   *  LF --------- RF   LF --------- RF    LF --------- RF   LF --------- RF
   */
  #define LEVEL_CORNERS_LEVELING_ORDER { LF, RF, RB, LB }
#endif

/**
 * Commands to execute at the end of G29 probing.
 * Useful to retract or move the Z probe out of the way.
 */
//#define Z_PROBE_END_SCRIPT "G1 Z10 F12000\nG1 X15 Y330\nG1 Z0.5\nG1 Z10"

// @section homing

// The center of the bed is at (X=0, Y=0)
//#define BED_CENTER_AT_0_0

// Manually set the home position. Leave these undefined for automatic settings.
// For DELTA this is the top-center of the Cartesian print volume.
//#define MANUAL_X_HOME_POS 0
//#define MANUAL_Y_HOME_POS 0
//#define MANUAL_Z_HOME_POS 0
//#define MANUAL_I_HOME_POS 0
//#define MANUAL_J_HOME_POS 0
//#define MANUAL_K_HOME_POS 0

/**
 * Use "Z Safe Homing" to avoid homing with a Z probe outside the bed area.
 *
 * - Moves the Z probe (or nozzle) to a defined XY point before Z homing.
 * - Allows Z homing only when XY positions are known and trusted.
 * - If stepper drivers sleep, XY homing may be required again before Z homing.
 */
//#define Z_SAFE_HOMING

#if ENABLED(Z_SAFE_HOMING)
  #define Z_SAFE_HOMING_X_POINT X_CENTER  // X point for Z homing
  #define Z_SAFE_HOMING_Y_POINT Y_CENTER  // Y point for Z homing
#endif

// Homing speeds (mm/min)
#define HOMING_FEEDRATE_MM_M { (50*60), (50*60), (4*60) }

// Validate that endstops are triggered on homing moves
#define VALIDATE_HOMING_ENDSTOPS

// @section calibrate

/**
 * Bed Skew Compensation
 *
 * This feature corrects for misalignment in the XYZ axes.
 *
 * Take the following steps to get the bed skew in the XY plane:
```

```
 *  1. Print a test square (e.g., https://www.thingiverse.com/thing:2563185)
 *  2. For XY_DIAG_AC measure the diagonal A to C
 *  3. For XY_DIAG_BD measure the diagonal B to D
 *  4. For XY_SIDE_AD measure the edge A to D
 *
 * Marlin automatically computes skew factors from these measurements.
 * Skew factors may also be computed and set manually:
 *
 *  - Compute AB     : SQRT(2*AC*AC+2*BD*BD-4*AD*AD)/2
 *  - XY_SKEW_FACTOR : TAN(PI/2-ACOS((AC*AC-AB*AB-AD*AD)/(2*AB*AD)))
 *
 * If desired, follow the same procedure for XZ and YZ.
 * Use these diagrams for reference:
 *
 *    Y                     Z                     Z
 *    ^     B-------C       ^     B-------C       ^     B-------C
 *    |    /       /        |    /       /        |    /       /
 *    |   /       /         |   /       /         |   /       /
 *    |  A-------D          |  A-------D          |  A-------D
 *    +-------------->X     +-------------->X     +-------------->Y
 *     XY_SKEW_FACTOR        XZ_SKEW_FACTOR        YZ_SKEW_FACTOR
 */
//#define SKEW_CORRECTION

#if ENABLED(SKEW_CORRECTION)
  // Input all length measurements here:
  #define XY_DIAG_AC 282.8427124746
  #define XY_DIAG_BD 282.8427124746
  #define XY_SIDE_AD 200

  // Or, set the default skew factors directly here
  // to override the above measurements:
  #define XY_SKEW_FACTOR 0.0

  //#define SKEW_CORRECTION_FOR_Z
  #if ENABLED(SKEW_CORRECTION_FOR_Z)
    #define XZ_DIAG_AC 282.8427124746
    #define XZ_DIAG_BD 282.8427124746
    #define YZ_DIAG_AC 282.8427124746
    #define YZ_DIAG_BD 282.8427124746
    #define YZ_SIDE_AD 200
    #define XZ_SKEW_FACTOR 0.0
    #define YZ_SKEW_FACTOR 0.0
  #endif

  // Enable this option for M852 to set skew at runtime
  //#define SKEW_CORRECTION_GCODE
#endif

//=========================================================================
//============================ Additional Features ============================
//=========================================================================

// @section extras
```

```
/**
 * EEPROM
 *
 * Persistent storage to preserve configurable settings across reboots.
 *
 *   M500 - Store settings to EEPROM.
 *   M501 - Read settings from EEPROM. (i.e., Throw away unsaved changes)
 *   M502 - Revert settings to "factory" defaults. (Follow with M500 to init the EEPROM.)
 */
#define EEPROM_SETTINGS     // Persistent storage with M500 and M501
//#define DISABLE_M503        // Saves ~2700 bytes of PROGMEM. Disable for release!
#define EEPROM_CHITCHAT       // Give feedback on EEPROM commands. Disable to save PROGMEM.
#define EEPROM_BOOT_SILENT    // Keep M503 quiet and only give errors during first load
#if ENABLED(EEPROM_SETTINGS)
  #define EEPROM_AUTO_INIT  // Init EEPROM automatically on any errors.
#endif

//
// Host Keepalive
//
// When enabled Marlin will send a busy status message to the host
// every couple of seconds when it can't accept commands.
//
#define HOST_KEEPALIVE_FEATURE        // Disable this if your host doesn't like keepalive messages
#define DEFAULT_KEEPALIVE_INTERVAL 2  // Number of seconds between "busy" messages. Set with M113.
#define BUSY_WHILE_HEATING            // Some hosts require "busy" messages even during heating

//
// G20/G21 Inch mode support
//
//#define INCH_MODE_SUPPORT

//
// M149 Set temperature units support
//
//#define TEMPERATURE_UNITS_SUPPORT

// @section temperature

//
// Preheat Constants - Up to 5 are supported without changes
//
#define PREHEAT_1_LABEL       "PLA"
#define PREHEAT_1_TEMP_HOTEND 180
#define PREHEAT_1_TEMP_BED     70
#define PREHEAT_1_TEMP_CHAMBER 45
#define PREHEAT_1_FAN_SPEED     0 // Value from 0 to 255

#define PREHEAT_2_LABEL       "ABS"
#define PREHEAT_2_TEMP_HOTEND 240
#define PREHEAT_2_TEMP_BED    110
#define PREHEAT_2_TEMP_CHAMBER 50
```

```
#define PREHEAT_2_FAN_SPEED     0 // Value from 0 to 255

#define PREHEAT_3_LABEL         "HDPE"
#define PREHEAT_3_TEMP_HOTEND   250
#define PREHEAT_3_TEMP_BED      110
#define PREHEAT_3_TEMP_CHAMBER  70
#define PREHEAT_3_FAN_SPEED     0 // Value from 0 to 255

/**
 * Nozzle Park
 *
 * Park the nozzle at the given XYZ position on idle or G27.
 *
 * The "P" parameter controls the action applied to the Z axis:
 *
 *    P0  (Default) If Z is below park Z raise the nozzle.
 *    P1  Raise the nozzle always to Z-park height.
 *    P2  Raise the nozzle by Z-park amount, limited to Z_MAX_POS.
 */
//#define NOZZLE_PARK_FEATURE

#if ENABLED(NOZZLE_PARK_FEATURE)
  // Specify a park position as { X, Y, Z_raise }
  #define NOZZLE_PARK_POINT { (X_MIN_POS + 10), (Y_MAX_POS - 10), 20 }
  //#define NOZZLE_PARK_X_ONLY          // X move only is required to park
  //#define NOZZLE_PARK_Y_ONLY          // Y move only is required to park
  #define NOZZLE_PARK_Z_RAISE_MIN   2   // (mm) Always raise Z by at least this distance
  #define NOZZLE_PARK_XY_FEEDRATE 100   // (mm/s) X and Y axes feedrate (also used for delta Z axis)
  #define NOZZLE_PARK_Z_FEEDRATE    5   // (mm/s) Z axis feedrate (not used for delta printers)
#endif

/**
 * Clean Nozzle Feature -- EXPERIMENTAL
 *
 * Adds the G12 command to perform a nozzle cleaning process.
 *
 * Parameters:
 *   P  Pattern
 *   S  Strokes / Repetitions
 *   T  Triangles (P1 only)
 *
 * Patterns:
 *   P0  Straight line (default). This process requires a sponge type material
 *       at a fixed bed location. "S" specifies strokes (i.e. back-forth motions)
 *       between the start / end points.
 *
 *   P1  Zig-zag pattern between (X0, Y0) and (X1, Y1), "T" specifies the
 *       number of zig-zag triangles to do. "S" defines the number of strokes.
 *       Zig-zags are done in whichever is the narrower dimension.
 *       For example, "G12 P1 S1 T3" will execute:
 *
 *          --
```

```
 *         |  (X0, Y1) |     /\        /\        /\     | (X1, Y1)
 *         |           |    /  \      /  \      /  \    |
 *       A |           |   /    \    /    \    /    \   |
 *         |           |  /      \  /      \  /      \  |
 *         |  (X0, Y0) | /        \/        \/        \ | (X1, Y0)
 *          --         +-------------------------------+
 *                       |________|________|________|
 *                           T1       T2       T3
 *
 *   P2  Circular pattern with middle at NOZZLE_CLEAN_CIRCLE_MIDDLE.
 *       "R" specifies the radius. "S" specifies the stroke count.
 *       Before starting, the nozzle moves to NOZZLE_CLEAN_START_POINT.
 *
 *   Caveats: The ending Z should be the same as starting Z.
 * Attention: EXPERIMENTAL. G-code arguments may change.
 */
//#define NOZZLE_CLEAN_FEATURE

#if ENABLED(NOZZLE_CLEAN_FEATURE)
  // Default number of pattern repetitions
  #define NOZZLE_CLEAN_STROKES  12

  // Default number of triangles
  #define NOZZLE_CLEAN_TRIANGLES  3

  // Specify positions for each tool as { { X, Y, Z }, { X, Y, Z } }
  // Dual hotend system may use { {  -20, (Y_BED_SIZE / 2), (Z_MIN_POS + 1) },  {  420, (Y_BED_SIZE / 2), (Z_MIN_POS + 1) }}
  #define NOZZLE_CLEAN_START_POINT { {  30, 30, (Z_MIN_POS + 1) } }
  #define NOZZLE_CLEAN_END_POINT   { { 100, 60, (Z_MIN_POS + 1) } }

  // Circular pattern radius
  #define NOZZLE_CLEAN_CIRCLE_RADIUS 6.5
  // Circular pattern circle fragments number
  #define NOZZLE_CLEAN_CIRCLE_FN 10
  // Middle point of circle
  #define NOZZLE_CLEAN_CIRCLE_MIDDLE NOZZLE_CLEAN_START_POINT

  // Move the nozzle to the initial position after cleaning
  #define NOZZLE_CLEAN_GOBACK

  // For a purge/clean station that's always at the gantry height (thus no Z move)
  //#define NOZZLE_CLEAN_NO_Z

  // For a purge/clean station mounted on the X axis
  //#define NOZZLE_CLEAN_NO_Y

  // Require a minimum hotend temperature for cleaning
  #define NOZZLE_CLEAN_MIN_TEMP 170
  //#define NOZZLE_CLEAN_HEATUP       // Heat up the nozzle instead of skipping wipe

  // Explicit wipe G-code script applies to a G12 with no arguments.
  //#define WIPE_SEQUENCE_COMMANDS "G1 X-17 Y25 Z10 F4000\nG1 Z1\nM114\nG1 X-17 Y25\nG1 X-17 Y95\nG1 X-17 Y25\nG1 X-17 Y95\nG1 X-17 Y25\nG1 X-17 Y95\nG1 X-17 Y25\nG1 X-17 Y95\nG1 X-17 Y25\nG1 X-17 Y95\nG1 Z15\nM400\nG0 X-10.0 Y-9.0"
```

```
#endif

/**
 * Print Job Timer
 *
 * Automatically start and stop the print job timer on M104/M109/M140/M190/M141/M191.
 * The print job timer will only be stopped if the bed/chamber target temp is
 * below BED_MINTEMP/CHAMBER_MINTEMP.
 *
 *   M104 (hotend, no wait)  - high temp = none,        low temp = stop timer
 *   M109 (hotend, wait)     - high temp = start timer, low temp = stop timer
 *   M140 (bed, no wait)     - high temp = none,        low temp = stop timer
 *   M190 (bed, wait)        - high temp = start timer, low temp = none
 *   M141 (chamber, no wait) - high temp = none,        low temp = stop timer
 *   M191 (chamber, wait)    - high temp = start timer, low temp = none
 *
 * For M104/M109, high temp is anything over EXTRUDE_MINTEMP / 2.
 * For M140/M190, high temp is anything over BED_MINTEMP.
 * For M141/M191, high temp is anything over CHAMBER_MINTEMP.
 *
 * The timer can also be controlled with the following commands:
 *
 *   M75 - Start the print job timer
 *   M76 - Pause the print job timer
 *   M77 - Stop the print job timer
 */
#define PRINTJOB_TIMER_AUTOSTART

/**
 * Print Counter
 *
 * Track statistical data such as:
 *
 *  - Total print jobs
 *  - Total successful print jobs
 *  - Total failed print jobs
 *  - Total time printing
 *
 * View the current statistics with M78.
 */
//#define PRINTCOUNTER
#if ENABLED(PRINTCOUNTER)
  #define PRINTCOUNTER_SAVE_INTERVAL 60 // (minutes) EEPROM save interval during print
#endif

/**
 * Password
 *
 * Set a numerical password for the printer which can be requested:
 *
 *  - When the printer boots up
```

```
 *  - Upon opening the 'Print from Media' Menu
 *  - When SD printing is completed or aborted
 *
 * The following G-codes can be used:
 *
 *  M510 - Lock Printer. Blocks all commands except M511.
 *  M511 - Unlock Printer.
 *  M512 - Set, Change and Remove Password.
 *
 * If you forget the password and get locked out you'll need to re-flash
 * the firmware with the feature disabled, reset EEPROM, and (optionally)
 * re-flash the firmware again with this feature enabled.
 */
//#define PASSWORD_FEATURE
#if ENABLED(PASSWORD_FEATURE)
  #define PASSWORD_LENGTH 4                // (#) Number of digits (1-9). 3 or 4 is recommended
  #define PASSWORD_ON_STARTUP
  #define PASSWORD_UNLOCK_GCODE            // Unlock with the M511 P<password> command. Disable to prevent brute-force attack.
  #define PASSWORD_CHANGE_GCODE            // Change the password with M512 P<old> S<new>.
  //#define PASSWORD_ON_SD_PRINT_MENU      // This does not prevent gcodes from running
  //#define PASSWORD_AFTER_SD_PRINT_END
  //#define PASSWORD_AFTER_SD_PRINT_ABORT
  //#include "Configuration_Secure.h"      // External file with PASSWORD_DEFAULT_VALUE
#endif

//===========================================================================
//============================= LCD and SD support =============================
//===========================================================================

// @section lcd

/**
 * LCD LANGUAGE
 *
 * Select the language to display on the LCD. These languages are available:
 *
 *   en, an, bg, ca, cz, da, de, el, el_CY, es, eu, fi, fr, gl, hr, hu, it,
 *   jp_kana, ko_KR, nl, pl, pt, pt_br, ro, ru, sk, sv, tr, uk, vi, zh_CN, zh_TW
 *
 * :{ 'en':'English', 'an':'Aragonese', 'bg':'Bulgarian', 'ca':'Catalan', 'cz':'Czech', 'da':'Danish', 'de':'German', 'el':'Greek (Greece)', 'el_CY':'Greek (Cyprus)', 'es':'Spanish', 'eu':'Basque-Euskera', 'fi':'Finnish', 'fr':'French', 'gl':'Galician', 'hr':'Croatian', 'hu':'Hungarian', 'it':'Italian', 'jp_kana':'Japanese', 'ko_KR':'Korean (South Korea)', 'nl':'Dutch', 'pl':'Polish', 'pt':'Portuguese', 'pt_br':'Portuguese (Brazilian)', 'ro':'Romanian', 'ru':'Russian', 'sk':'Slovak', 'sv':'Swedish', 'tr':'Turkish', 'uk':'Ukrainian', 'vi':'Vietnamese', 'zh_CN':'Chinese (Simplified)', 'zh_TW':'Chinese (Traditional)' }
 */
```

```
 */
#define LCD_LANGUAGE en

/**
 * LCD Character Set
 *
 * Note: This option is NOT applicable to Graphical Displays.
 *
 * All character-based LCDs provide ASCII plus one of these
 * language extensions:
 *
 *  - JAPANESE ... the most common
 *  - WESTERN  ... with more accented characters
 *  - CYRILLIC ... for the Russian language
 *
 * To determine the language extension installed on your controller:
 *
 *  - Compile and upload with LCD_LANGUAGE set to 'test'
 *  - Click the controller to view the LCD menu
 *  - The LCD will display Japanese, Western, or Cyrillic text
 *
 * See https://marlinfw.org/docs/development/lcd_language.html
 *
 * :['JAPANESE', 'WESTERN', 'CYRILLIC']
 */
#define DISPLAY_CHARSET_HD44780 WESTERN

/**
 * Info Screen Style (0:Classic, 1:Průša)
 *
 * :[0:'Classic', 1:'Průša']
 */
#define LCD_INFO_SCREEN_STYLE 0

/**
 * SD CARD
 *
 * SD Card support is disabled by default. If your controller has an SD
slot,
 * you must uncomment the following option or it won't work.
 */
#define SDSUPPORT
//#define SD_CONNECTION_IS ONBOARD

/**
 * SD CARD: ENABLE CRC
 *
 * Use CRC checks and retries on the SD communication.
 */
//#define SD_CHECK_AND_RETRY

/**
 * LCD Menu Items
 *
 * Disable all menus and only display the Status Screen, or
 * just remove some extraneous menu items to recover space.
 */
//#define NO_LCD_MENUS
//#define SLIM_LCD_MENUS
```

```
2122
2123 //
2124 // ENCODER SETTINGS
2125 //
2126 // This option overrides the default number of encoder pulses needed to
2127 // produce one step. Should be increased for high-resolution encoders.
2128 //
2129 //#define ENCODER_PULSES_PER_STEP 4
2130
2131 //
2132 // Use this option to override the number of step signals required to
2133 // move between next/prev menu items.
2134 //
2135 //#define ENCODER_STEPS_PER_MENU_ITEM 1
2136
2137 /**
2138  * Encoder Direction Options
2139  *
2140  * Test your encoder's behavior first with both options disabled.
2141  *
2142  *  Reversed Value Edit and Menu Nav? Enable REVERSE_ENCODER_DIRECTION.
2143  *  Reversed Menu Navigation only?    Enable REVERSE_MENU_DIRECTION.
2144  *  Reversed Value Editing only?      Enable BOTH options.
2145  */
2146
2147 //
2148 // This option reverses the encoder direction everywhere.
2149 //
2150 //  Set this option if CLOCKWISE causes values to DECREASE
2151 //
2152 //#define REVERSE_ENCODER_DIRECTION
2153
2154 //
2155 // This option reverses the encoder direction for navigating LCD menus.
2156 //
2157 //  If CLOCKWISE normally moves DOWN this makes it go UP.
2158 //  If CLOCKWISE normally moves UP this makes it go DOWN.
2159 //
2160 //#define REVERSE_MENU_DIRECTION
2161
2162 //
2163 // This option reverses the encoder direction for Select Screen.
2164 //
2165 //  If CLOCKWISE normally moves LEFT this makes it go RIGHT.
2166 //  If CLOCKWISE normally moves RIGHT this makes it go LEFT.
2167 //
2168 //#define REVERSE_SELECT_DIRECTION
2169
2170 //
2171 // Individual Axis Homing
2172 //
2173 // Add individual axis homing items (Home X, Home Y, and Home Z) to the LCD
    menu.
2174 //
2175 #define INDIVIDUAL_AXIS_HOMING_MENU
2176 #define INDIVIDUAL_AXIS_HOMING_SUBMENU
2177
2178 //
2179 // SPEAKER/BUZZER
```

```
// SPEAKER/BUZZER
//
// If you have a speaker that can produce tones, enable it here.
// By default Marlin assumes you have a buzzer with a fixed frequency.
//
#define SPEAKER

//
// The duration and frequency for the UI feedback sound.
// Set these to 0 to disable audio feedback in the LCD menus.
//
// Note: Test audio output with the G-Code:
//  M300 S<frequency Hz> P<duration ms>
//
//#define LCD_FEEDBACK_FREQUENCY_DURATION_MS 2
//#define LCD_FEEDBACK_FREQUENCY_HZ 5000

//============================================================================
//========================== LCD / Controller Selection ==========================
//========================   (Character-based LCDs)   ========================
//============================================================================

//
// RepRapDiscount Smart Controller.
// https://reprap.org/wiki/RepRapDiscount_Smart_Controller
//
// Note: Usually sold with a white PCB.
//
//#define REPRAP_DISCOUNT_SMART_CONTROLLER

//
// GT2560 (YHCB2004) LCD Display
//
// Requires Testato, Koepel softwarewire library and
// Andriy Golovnya's LiquidCrystal_AIP31068 library.
//
//#define YHCB2004

//
// Original RADDS LCD Display+Encoder+SDCardReader
// http://doku.radds.org/dokumentation/lcd-display/
//
//#define RADDS_DISPLAY

//
// ULTIMAKER Controller.
//
//#define ULTIMAKERCONTROLLER

//
// ULTIPANEL as seen on Thingiverse.
//
//#define ULTIPANEL

//
```

```
// PanelOne from T3P3 (via RAMPS 1.4 AUX2/AUX3)
// https://reprap.org/wiki/PanelOne
//
//#define PANEL_ONE

//
// GADGETS3D G3D LCD/SD Controller
// https://reprap.org/wiki/RAMPS_1.3/1.4_GADGETS3D_Shield_with_Panel
//
// Note: Usually sold with a blue PCB.
//
//#define G3D_PANEL

//
// RigidBot Panel V1.0
// http://www.inventapart.com/
//
//#define RIGIDBOT_PANEL

//
// Makeboard 3D Printer Parts 3D Printer Mini Display 1602 Mini Controller
// https://www.aliexpress.com/item/32765887917.html
//
//#define MAKEBOARD_MINI_2_LINE_DISPLAY_1602

//
// ANET and Tronxy 20x4 Controller
//
//#define ZONESTAR_LCD            // Requires ADC_KEYPAD_PIN to be assigned to an analog pin.
                                  // This LCD is known to be susceptible to electrical interference
                                  // which scrambles the display.  Pressing any button clears it up.
                                  // This is a LCD2004 display with 5 analog buttons.

//
// Generic 16x2, 16x4, 20x2, or 20x4 character-based LCD.
//
//#define ULTRA_LCD

//===========================================================================
//=========================== LCD / Controller Selection =========================
//=====================   (I2C and Shift-Register LCDs)   ====================
//===========================================================================

//
// CONTROLLER TYPE: I2C
//
// Note: These controllers require the installation of Arduino's LiquidCrystal_I2C
// library. For more info: https://github.com/kiyoshigawa/LiquidCrystal_I2C
//
```

```
//
// Elefu RA Board Control Panel
// http://www.elefu.com/index.php?route=product/product&product_id=53
//
//#define RA_CONTROL_PANEL

//
// Sainsmart (YwRobot) LCD Displays
//
// These require F.Malpartida's LiquidCrystal_I2C library
// https://bitbucket.org/fmalpartida/new-liquidcrystal/wiki/Home
//
//#define LCD_SAINSMART_I2C_1602
//#define LCD_SAINSMART_I2C_2004

//
// Generic LCM1602 LCD adapter
//
//#define LCM1602

//
// PANELOLU2 LCD with status LEDs,
// separate encoder and click inputs.
//
// Note: This controller requires Arduino's LiquidTWI2 library v1.2.3 or later.
// For more info: https://github.com/lincomatic/LiquidTWI2
//
// Note: The PANELOLU2 encoder click input can either be directly connected to
// a pin (if BTN_ENC defined to != -1) or read through I2C (when BTN_ENC == -1).
//
//#define LCD_I2C_PANELOLU2

//
// Panucatt VIKI LCD with status LEDs,
// integrated click & L/R/U/D buttons, separate encoder inputs.
//
//#define LCD_I2C_VIKI

//
// CONTROLLER TYPE: Shift register panels
//

//
// 2-wire Non-latching LCD SR from https://goo.gl/aJJ4sH
// LCD configuration: https://reprap.org/wiki/SAV_3D_LCD
//
//#define SAV_3DLCD

//
// 3-wire SR LCD with strobe using 74HC4094
// https://github.com/mikeshub/SailfishLCD
// Uses the code directly from Sailfish
//
//#define FF_INTERFACEBOARD

```

```
//
// TFT GLCD Panel with Marlin UI
// Panel connected to main board by SPI or I2C interface.
// See https://github.com/Serhiy-K/TFTGLCDAdapter
//
//#define TFTGLCD_PANEL_SPI
//#define TFTGLCD_PANEL_I2C

//==============================================================================
//=======================   LCD / Controller Selection  =======================
//=========================      (Graphical LCDs)  =============================
//==============================================================================

//
// CONTROLLER TYPE: Graphical 128x64 (DOGM)
//
// IMPORTANT: The U8glib library is required for Graphical Display!
//            https://github.com/olikraus/U8glib_Arduino
//
// NOTE: If the LCD is unresponsive you may need to reverse the plugs.
//

//
// RepRapDiscount FULL GRAPHIC Smart Controller
// https://reprap.org/wiki/RepRapDiscount_Full_Graphic_Smart_Controller
//
//#define REPRAP_DISCOUNT_FULL_GRAPHIC_SMART_CONTROLLER

//
// K.3D Full Graphic Smart Controller
//
//#define K3D_FULL_GRAPHIC_SMART_CONTROLLER

//
// ReprapWorld Graphical LCD
// https://reprapworld.com/?products_details&products_id/1218
//
//#define REPRAPWORLD_GRAPHICAL_LCD

//
// Activate one of these if you have a Panucatt Devices
// Viki 2.0 or mini Viki with Graphic LCD
// https://www.panucatt.com
//
//#define VIKI2
//#define miniVIKI

//
// MakerLab Mini Panel with graphic
// controller and SD support - https://reprap.org/wiki/Mini_panel
//
//#define MINIPANEL

//
// MaKr3d Makr-Panel with graphic controller and SD support
```

```
// MaKr3d MaKrPanel with graphic controller and SD support.
// https://reprap.org/wiki/MaKr3d_MaKrPanel
//
//#define MAKRPANEL

//
// Adafruit ST7565 Full Graphic Controller.
// https://github.com/eboston/Adafruit-ST7565-Full-Graphic-Controller/
//
//#define ELB_FULL_GRAPHIC_CONTROLLER

//
// BQ LCD Smart Controller shipped by
// default with the BQ Hephestos 2 and Witbox 2.
//
//#define BQ_LCD_SMART_CONTROLLER

//
// Cartesio UI
// http://mauk.cc/webshop/cartesio-shop/electronics/user-interface
//
//#define CARTESIO_UI

//
// LCD for Melzi Card with Graphical LCD
//
//#define LCD_FOR_MELZI

//
// Original Ulticontroller from Ultimaker 2 printer with SSD1309 I2C display and encoder
//
https://github.com/Ultimaker/Ultimaker2/tree/master/1249_Ulticontroller_Board_(x1)
//
//#define ULTI_CONTROLLER

//
// MKS MINI12864 with graphic controller and SD support
// https://reprap.org/wiki/MKS_MINI_12864
//
//#define MKS_MINI_12864

//
// MKS MINI12864 V3 is an alias for FYSETC_MINI_12864_2_1. Type A/B. NeoPixel RGB Backlight.
//
//#define MKS_MINI_12864_V3

//
// MKS LCD12864A/B with graphic controller and SD support. Follows MKS_MINI_12864 pinout.
// https://www.aliexpress.com/item/33018110072.html
//
//#define MKS_LCD12864A
//#define MKS_LCD12864B

//
// FYSETC variant of the MINI12864 graphic controller with SD support
```

```
// https://wiki.fysetc.com/Mini12864_Panel/
//
//#define FYSETC_MINI_12864_X_X    // Type C/D/E/F. No tunable RGB Backlight by default
//#define FYSETC_MINI_12864_1_2    // Type C/D/E/F. Simple RGB Backlight (always on)
//#define FYSETC_MINI_12864_2_0    // Type A/B. Discreet RGB Backlight
//#define FYSETC_MINI_12864_2_1    // Type A/B. NeoPixel RGB Backlight
//#define FYSETC_GENERIC_12864_1_1 // Larger display with basic ON/OFF backlight.

//
// Factory display for Creality CR-10
// https://www.aliexpress.com/item/32833148327.html
//
// This is RAMPS-compatible using a single 10-pin connector.
// (For CR-10 owners who want to replace the Melzi Creality board but retain the display)
//
#define CR10_STOCKDISPLAY

//
// Ender-2 OEM display, a variant of the MKS_MINI_12864
//
//#define ENDER2_STOCKDISPLAY

//
// ANET and Tronxy Graphical Controller
//
// Anet 128x64 full graphics lcd with rotary encoder as used on Anet A6
// A clone of the RepRapDiscount full graphics display but with
// different pins/wiring (see pins_ANET_10.h). Enable one of these.
//
//#define ANET_FULL_GRAPHICS_LCD
//#define ANET_FULL_GRAPHICS_LCD_ALT_WIRING

//
// AZSMZ 12864 LCD with SD
// https://www.aliexpress.com/item/32837222770.html
//
//#define AZSMZ_12864

//
// Silvergate GLCD controller
// https://github.com/android444/Silvergate
//
//#define SILVER_GATE_GLCD_CONTROLLER

//==============================================================================
//============================  OLED Displays  ============================
//==============================================================================

//
// SSD1306 OLED full graphics generic display
//
//#define U8GLIB_SSD1306
```

```
//#define U8GLIB_SSD1306

//
// SAV OLEd LCD module support using either SSD1306 or SH1106 based LCD modules
//
//#define SAV_3DGLCD
#if ENABLED(SAV_3DGLCD)
  #define U8GLIB_SSD1306
  //#define U8GLIB_SH1106
#endif

//
// TinyBoy2 128x64 OLED / Encoder Panel
//
//#define OLED_PANEL_TINYBOY2

//
// MKS OLED 1.3" 128×64 Full Graphics Controller
// https://reprap.org/wiki/MKS_12864OLED
//
// Tiny, but very sharp OLED display
//
//#define MKS_12864OLED          // Uses the SH1106 controller (default)
//#define MKS_12864OLED_SSD1306  // Uses the SSD1306 controller

//
// Zonestar OLED 128×64 Full Graphics Controller
//
//#define ZONESTAR_12864LCD           // Graphical (DOGM) with ST7920 controller
//#define ZONESTAR_12864OLED          // 1.3" OLED with SH1106 controller (default)
//#define ZONESTAR_12864OLED_SSD1306  // 0.96" OLED with SSD1306 controller

//
// Einstart S OLED SSD1306
//
//#define U8GLIB_SH1106_EINSTART

//
// Overlord OLED display/controller with i2c buzzer and LEDs
//
//#define OVERLORD_OLED

//
// FYSETC OLED 2.42" 128×64 Full Graphics Controller with WS2812 RGB
// Where to find : https://www.aliexpress.com/item/4000345255731.html
//#define FYSETC_242_OLED_12864   // Uses the SSD1309 controller

//
// K.3D SSD1309 OLED 2.42" 128×64 Full Graphics Controller
//
//#define K3D_242_OLED_CONTROLLER   // Software SPI

//=============================================================================
//============================ Extensible UI Displays ============================
```

```
//===========================================================================
===

//
// DGUS Touch Display with DWIN OS. (Choose one.)
// ORIGIN : https://www.aliexpress.com/item/32993409517.html
// FYSETC : https://www.aliexpress.com/item/32961471929.html
// MKS    : https://www.aliexpress.com/item/1005002008179262.html
//
// Flash display with DGUS Displays for Marlin:
//  - Format the SD card to FAT32 with an allocation size of 4kb.
//  - Download files as specified for your type of display.
//  - Plug the microSD card into the back of the display.
//  - Boot the display and wait for the update to complete.
//
// ORIGIN (Marlin DWIN_SET)
//  - Download https://github.com/coldtobi/Marlin_DGUS_Resources
//  - Copy the downloaded DWIN_SET folder to the SD card.
//
// FYSETC (Supplier default)
//  - Download https://github.com/FYSETC/FYSTLCD-2.0
//  - Copy the downloaded SCREEN folder to the SD card.
//
// HIPRECY (Supplier default)
//  - Download https://github.com/HiPrecy/Touch-Lcd-LEO
//  - Copy the downloaded DWIN_SET folder to the SD card.
//
// MKS (MKS-H43) (Supplier default)
//  - Download https://github.com/makerbase-mks/MKS-H43
//  - Copy the downloaded DWIN_SET folder to the SD card.
//
// RELOADED (T5UID1)
//  - Download https://github.com/Desuuuu/DGUS-reloaded/releases
//  - Copy the downloaded DWIN_SET folder to the SD card.
//
//#define DGUS_LCD_UI_ORIGIN
//#define DGUS_LCD_UI_FYSETC
//#define DGUS_LCD_UI_HIPRECY
//#define DGUS_LCD_UI_MKS
//#define DGUS_LCD_UI_RELOADED
#if ENABLED(DGUS_LCD_UI_MKS)
  #define USE_MKS_GREEN_UI
#endif

//
// Touch-screen LCD for Malyan M200/M300 printers
//
//#define MALYAN_LCD
#if ENABLED(MALYAN_LCD)
  #define LCD_SERIAL_PORT 1  // Default is 1 for Malyan M200
#endif

//
// Touch UI for FTDI EVE (FT800/FT810) displays
// See Configuration_adv.h for all configuration options.
//
//#define TOUCH_UI_FTDI_EVE

//
```

```
//
// Touch-screen LCD for Anycubic printers
//
//#define ANYCUBIC_LCD_I3MEGA
//#define ANYCUBIC_LCD_CHIRON
#if EITHER(ANYCUBIC_LCD_I3MEGA, ANYCUBIC_LCD_CHIRON)
  #define LCD_SERIAL_PORT 3  // Default is 3 for Anycubic
  //#define ANYCUBIC_LCD_DEBUG
#endif

//
// 320x240 Nextion 2.8" serial TFT Resistive Touch Screen NX3224T028
//
//#define NEXTION_TFT
#if ENABLED(NEXTION_TFT)
  #define LCD_SERIAL_PORT 1  // Default is 1 for Nextion
#endif

//
// Third-party or vendor-customized controller interfaces.
// Sources should be installed in 'src/lcd/extui'.
//
//#define EXTENSIBLE_UI

#if ENABLED(EXTENSIBLE_UI)
  //#define EXTUI_LOCAL_BEEPER // Enables use of local Beeper pin with external display
#endif

//==============================================================================
//============================== Graphical TFTs ==============================
//==============================================================================

/**
 * Specific TFT Model Presets. Enable one of the following options
 * or enable TFT_GENERIC and set sub-options.
 */

//
// 480x320, 3.5", SPI Display From MKS
// Normally used in MKS Robin Nano V2
//
//#define MKS_TS35_V2_0

//
// 320x240, 2.4", FSMC Display From MKS
// Normally used in MKS Robin Nano V1.2
//
//#define MKS_ROBIN_TFT24

//
// 320x240, 2.8", FSMC Display From MKS
// Normally used in MKS Robin Nano V1.2
//
//#define MKS_ROBIN_TFT28

```

```
//
// 320x240, 3.2", FSMC Display From MKS
// Normally used in MKS Robin Nano V1.2
//
//#define MKS_ROBIN_TFT32

//
// 480x320, 3.5", FSMC Display From MKS
// Normally used in MKS Robin Nano V1.2
//
//#define MKS_ROBIN_TFT35

//
// 480x272, 4.3", FSMC Display From MKS
//
//#define MKS_ROBIN_TFT43

//
// 320x240, 3.2", FSMC Display From MKS
// Normally used in MKS Robin
//
//#define MKS_ROBIN_TFT_V1_1R

//
// 480x320, 3.5", FSMC Stock Display from TronxXY
//
//#define TFT_TRONXY_X5SA

//
// 480x320, 3.5", FSMC Stock Display from AnyCubic
//
//#define ANYCUBIC_TFT35

//
// 320x240, 2.8", FSMC Stock Display from Longer/Alfawise
//
//#define LONGER_LK_TFT28

//
// 320x240, 2.8", FSMC Stock Display from ET4
//
//#define ANET_ET4_TFT28

//
// 480x320, 3.5", FSMC Stock Display from ET5
//
//#define ANET_ET5_TFT35

//
// 1024x600, 7", RGB Stock Display from BIQU-BX
//
//#define BIQU_BX_TFT70

//
// Generic TFT with detailed options
//
//#define TFT_GENERIC
#if ENABLED(TFT_GENERIC)
```

```
  // :[ 'AUTO', 'ST7735', 'ST7789', 'ST7796', 'R61505', 'ILI9328',
'ILI9341', 'ILI9488' ]
  #define TFT_DRIVER AUTO

  // Interface. Enable one of the following options:
  //#define TFT_INTERFACE_FSMC
  //#define TFT_INTERFACE_SPI

  // TFT Resolution. Enable one of the following options:
  //#define TFT_RES_320x240
  //#define TFT_RES_480x272
  //#define TFT_RES_480x320
  //#define TFT_RES_1024x600
#endif

/**
 * TFT UI - User Interface Selection. Enable one of the following options:
 *
 *   TFT_CLASSIC_UI - Emulated DOGM - 128x64 Upscaled
 *   TFT_COLOR_UI   - Marlin Default Menus, Touch Friendly, using full TFT
capabilities
 *   TFT_LVGL_UI    - A Modern UI using LVGL
 *
 *   For LVGL_UI also copy the 'assets' folder from the build directory to
the
 *   root of your SD card, together with the compiled firmware.
 */
//#define TFT_CLASSIC_UI
//#define TFT_COLOR_UI
//#define TFT_LVGL_UI

#if ENABLED(TFT_LVGL_UI)
  //#define MKS_WIFI_MODULE  // MKS WiFi module
#endif

/**
 * TFT Rotation. Set to one of the following values:
 *
 *   TFT_ROTATE_90,  TFT_ROTATE_90_MIRROR_X,  TFT_ROTATE_90_MIRROR_Y,
 *   TFT_ROTATE_180, TFT_ROTATE_180_MIRROR_X, TFT_ROTATE_180_MIRROR_Y,
 *   TFT_ROTATE_270, TFT_ROTATE_270_MIRROR_X, TFT_ROTATE_270_MIRROR_Y,
 *   TFT_MIRROR_X, TFT_MIRROR_Y, TFT_NO_ROTATION
 */
//#define TFT_ROTATION TFT_NO_ROTATION

//=============================================================================
//============================  Other Controllers  ============================
//=============================================================================

//
// Ender-3 v2 OEM display. A DWIN display with Rotary Encoder.
//
//#define DWIN_CREALITY_LCD

//
// Ender-3 v2 OEM display, enhanced.
```

```
//
//#define DWIN_CREALITY_LCD_ENHANCED

//
// Ender-3 v2 OEM display with enhancements by Jacob Myers
//
//#define DWIN_CREALITY_LCD_JYERSUI

//
// MarlinUI for Creality's DWIN display (and others)
//
//#define DWIN_MARLINUI_PORTRAIT
//#define DWIN_MARLINUI_LANDSCAPE

//
// Touch Screen Settings
//
//#define TOUCH_SCREEN
#if ENABLED(TOUCH_SCREEN)
  #define BUTTON_DELAY_EDIT  50 // (ms) Button repeat delay for edit screens
  #define BUTTON_DELAY_MENU 250 // (ms) Button repeat delay for menus

  //#define TOUCH_IDLE_SLEEP 300 // (secs) Turn off the TFT backlight if set (5mn)

  #define TOUCH_SCREEN_CALIBRATION

  //#define TOUCH_CALIBRATION_X 12316
  //#define TOUCH_CALIBRATION_Y -8981
  //#define TOUCH_OFFSET_X        -43
  //#define TOUCH_OFFSET_Y        257
  //#define TOUCH_ORIENTATION TOUCH_LANDSCAPE

  #if BOTH(TOUCH_SCREEN_CALIBRATION, EEPROM_SETTINGS)
    #define TOUCH_CALIBRATION_AUTO_SAVE // Auto save successful calibration values to EEPROM
  #endif

  #if ENABLED(TFT_COLOR_UI)
    //#define SINGLE_TOUCH_NAVIGATION
  #endif
#endif

//
// RepRapWorld REPRAPWORLD_KEYPAD v1.1
//
https://reprapworld.com/products/electronics/ramps/keypad_v1_0_fully_assembled/
//
//#define REPRAPWORLD_KEYPAD
//#define REPRAPWORLD_KEYPAD_MOVE_STEP 10.0 // (mm) Distance to move per key-press

//===========================================================================
//============================= Extra Features ==============================
//===========================================================================
```

```
===

// @section extras

// Set number of user-controlled fans. Disable to use all board-defined fans.
// :[1,2,3,4,5,6,7,8]
//#define NUM_M106_FANS 1

// Increase the FAN PWM frequency. Removes the PWM noise but increases heating in the FET/Arduino
//#define FAST_PWM_FAN

// Use software PWM to drive the fan, as for the heaters. This uses a very low frequency
// which is not as annoying as with the hardware PWM. On the other hand, if this frequency
// is too low, you should also increment SOFT_PWM_SCALE.
//#define FAN_SOFT_PWM

// Incrementing this by 1 will double the software PWM frequency,
// affecting heaters, and the fan if FAN_SOFT_PWM is enabled.
// However, control resolution will be halved for each increment;
// at zero value, there are 128 effective control positions.
// :[0,1,2,3,4,5,6,7]
#define SOFT_PWM_SCALE 0

// If SOFT_PWM_SCALE is set to a value higher than 0, dithering can
// be used to mitigate the associated resolution loss. If enabled,
// some of the PWM cycles are stretched so on average the desired
// duty cycle is attained.
//#define SOFT_PWM_DITHER

// Temperature status LEDs that display the hotend and bed temperature.
// If all hotends, bed temperature, and target temperature are under 54C
// then the BLUE led is on. Otherwise the RED led is on. (1C hysteresis)
//#define TEMP_STAT_LEDS

// Support for the BariCUDA Paste Extruder
//#define BARICUDA

// Support for BlinkM/CyzRgb
//#define BLINKM

// Support for PCA9632 PWM LED driver
//#define PCA9632

// Support for PCA9533 PWM LED driver
//#define PCA9533

/**
 * RGB LED / LED Strip Control
 *
 * Enable support for an RGB LED connected to 5V digital pins, or
 * an RGB Strip connected to MOSFETs controlled by digital pins.
 *
 * Adds the M150 command to set the LED (or LED strip) color.
 * If pins are PWM capable (e.g., 4, 5, 6, 11) then a range of
 * luminance values can be set from 0 to 255.
```

```
 * For NeoPixel LED an overall brightness parameter is also available.
 *
 * *** CAUTION ***
 *  LED Strips require a MOSFET Chip between PWM lines and LEDs,
 *  as the Arduino cannot handle the current the LEDs will require.
 *  Failure to follow this precaution can destroy your Arduino!
 *  NOTE: A separate 5V power supply is required! The NeoPixel LED needs
 *  more current than the Arduino 5V linear regulator can produce.
 * *** CAUTION ***
 *
 * LED Type. Enable only one of the following two options.
 */
//#define RGB_LED
//#define RGBW_LED

#if EITHER(RGB_LED, RGBW_LED)
  //#define RGB_LED_R_PIN 34
  //#define RGB_LED_G_PIN 43
  //#define RGB_LED_B_PIN 35
  //#define RGB_LED_W_PIN -1
#endif

// Support for Adafruit NeoPixel LED driver
//#define NEOPIXEL_LED
#if ENABLED(NEOPIXEL_LED)
  #define NEOPIXEL_TYPE   NEO_GRBW // NEO_GRBW / NEO_GRB - four/three channel driver type (defined in Adafruit_NeoPixel.h)
  //#define NEOPIXEL_PIN     4     // LED driving pin
  //#define NEOPIXEL2_TYPE NEOPIXEL_TYPE
  //#define NEOPIXEL2_PIN    5
  #define NEOPIXEL_PIXELS 30       // Number of LEDs in the strip. (Longest strip when NEOPIXEL2_SEPARATE is disabled.)
  #define NEOPIXEL_IS_SEQUENTIAL   // Sequential display for temperature change - LED by LED. Disable to change all LEDs at once.
  #define NEOPIXEL_BRIGHTNESS 127  // Initial brightness (0-255)
  //#define NEOPIXEL_STARTUP_TEST  // Cycle through colors at startup

  // Support for second Adafruit NeoPixel LED driver controlled with M150 S1 ...
  //#define NEOPIXEL2_SEPARATE
  #if ENABLED(NEOPIXEL2_SEPARATE)
    #define NEOPIXEL2_PIXELS      15  // Number of LEDs in the second strip
    #define NEOPIXEL2_BRIGHTNESS 127  // Initial brightness (0-255)
    #define NEOPIXEL2_STARTUP_TEST    // Cycle through colors at startup
  #else
    //#define NEOPIXEL2_INSERIES      // Default behavior is NeoPixel 2 in parallel
  #endif

  // Use some of the NeoPixel LEDs for static (background) lighting
  //#define NEOPIXEL_BKGD_INDEX_FIRST  0              // Index of the first background LED
  //#define NEOPIXEL_BKGD_INDEX_LAST   5              // Index of the last background LED
  //#define NEOPIXEL_BKGD_COLOR { 255, 255, 255, 0 }  // R, G, B, W
  //#define NEOPIXEL_BKGD_ALWAYS_ON                   // Keep the backlight on when other NeoPixels are off
#endif
```

```
2930
2931 /**
2932  * Printer Event LEDs
2933  *
2934  * During printing, the LEDs will reflect the printer status:
2935  *
2936  *  - Gradually change from blue to violet as the heated bed gets to target
     temp
2937  *  - Gradually change from violet to red as the hotend gets to temperature
2938  *  - Change to white to illuminate work surface
2939  *  - Change to green once print has finished
2940  *  - Turn off after the print has finished and the user has pushed a button
2941  */
2942 #if ANY(BLINKM, RGB_LED, RGBW_LED, PCA9632, PCA9533, NEOPIXEL_LED)
2943   #define PRINTER_EVENT_LEDS
2944 #endif
2945
2946 /**
2947  * Number of servos
2948  *
2949  * For some servo-related options NUM_SERVOS will be set automatically.
2950  * Set this manually if there are extra servos needing manual control.
2951  * Set to 0 to turn off servo support.
2952  */
2953 //#define NUM_SERVOS 3 // Note: Servo index starts with 0 for M280-M282
     commands
2954
2955 // (ms) Delay before the next move will start, to give the servo time to
     reach its target angle.
2956 // 300ms is a good value but you can try less delay.
2957 // If the servo can't reach the requested position, increase it.
2958 #define SERVO_DELAY { 300 }
2959
2960 // Only power servos during movement, otherwise leave off to prevent jitter
2961 //#define DEACTIVATE_SERVOS_AFTER_MOVE
2962
2963 // Edit servo angles with M281 and save to EEPROM with M500
2964 //#define EDITABLE_SERVO_ANGLES
2965
2966 // Disable servo with M282 to reduce power consumption, noise, and heat when
     not in use
2967 //#define SERVO_DETACH_GCODE
2968
```

I Configuration advanced

```
/**
 * Marlin 3D Printer Firmware
 * Copyright (c) 2020 MarlinFirmware
[https://github.com/MarlinFirmware/Marlin]
 *
 * Based on Sprinter and grbl.
 * Copyright (c) 2011 Camiel Gubbels / Erik van der Zalm
 *
 * This program is free software: you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program.  If not, see <https://www.gnu.org/licenses/>.
 *
 */
#pragma once

/**
 * Configuration_adv.h
 *
 * Advanced settings.
 * Only change these if you know exactly what you're doing.
 * Some of these settings can damage your printer if improperly set!
 *
 * Basic settings can be found in Configuration.h
 */
#define CONFIGURATION_ADV_H_VERSION 02000902

//===========================================================================
//============================= Thermal Settings ============================
//===========================================================================
// @section temperature

/**
 * Thermocouple sensors are quite sensitive to noise.  Any noise induced in
 * the sensor wires, such as by stepper motor wires run in parallel to them,
 * may result in the thermocouple sensor reporting spurious errors.  This
 * value is the number of errors which can occur in a row before the error
 * is reported.  This allows us to ignore intermittent error conditions
while
 * still detecting an actual failure, which should result in a continuous
 * stream of errors from the sensor.
 *
 * Set this value to 0 to fail on the first error to occur.
 */
#define THERMOCOUPLE_MAX_ERRORS 15

//
```

```
// Custom Thermistor 1000 parameters
//
#if TEMP_SENSOR_0 == 1000
  #define HOTEND0_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND0_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND0_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_1 == 1000
  #define HOTEND1_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND1_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND1_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_2 == 1000
  #define HOTEND2_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND2_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND2_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_3 == 1000
  #define HOTEND3_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND3_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND3_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_4 == 1000
  #define HOTEND4_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND4_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND4_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_5 == 1000
  #define HOTEND5_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND5_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND5_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_6 == 1000
  #define HOTEND6_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND6_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND6_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_7 == 1000
  #define HOTEND7_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define HOTEND7_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define HOTEND7_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_BED == 1000
  #define BED_PULLUP_RESISTOR_OHMS     4700    // Pullup resistor
  #define BED_RESISTANCE_25C_OHMS      100000  // Resistance at 25C
  #define BED_BETA                     3950    // Beta value
#endif

#if TEMP_SENSOR_CHAMBER == 1000
  #define CHAMBER_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define CHAMBER_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
```

```
  #define CHAMBER_BETA                     3950    // Beta value
#endif

#if TEMP_SENSOR_COOLER == 1000
  #define COOLER_PULLUP_RESISTOR_OHMS 4700    // Pullup resistor
  #define COOLER_RESISTANCE_25C_OHMS  100000  // Resistance at 25C
  #define COOLER_BETA                 3950    // Beta value
#endif

#if TEMP_SENSOR_PROBE == 1000
  #define PROBE_PULLUP_RESISTOR_OHMS   4700    // Pullup resistor
  #define PROBE_RESISTANCE_25C_OHMS    100000  // Resistance at 25C
  #define PROBE_BETA                   3950    // Beta value
#endif

#if TEMP_SENSOR_BOARD == 1000
  #define BOARD_PULLUP_RESISTOR_OHMS   4700    // Pullup resistor
  #define BOARD_RESISTANCE_25C_OHMS    100000  // Resistance at 25C
  #define BOARD_BETA                   3950    // Beta value
#endif

#if TEMP_SENSOR_REDUNDANT == 1000
  #define REDUNDANT_PULLUP_RESISTOR_OHMS   4700    // Pullup resistor
  #define REDUNDANT_RESISTANCE_25C_OHMS    100000  // Resistance at 25C
  #define REDUNDANT_BETA                   3950    // Beta value
#endif

/**
 * Configuration options for MAX Thermocouples (-2, -3, -5).
 *   FORCE_HW_SPI:   Ignore SCK/MOSI/MISO pins and just use the CS pin & default SPI bus.
 *   MAX31865_WIRES: Set the number of wires for the probe connected to a MAX31865 board, 2-4. Default: 2
 *   MAX31865_50HZ:  Enable 50Hz filter instead of the default 60Hz.
 */
//#define TEMP_SENSOR_FORCE_HW_SPI
//#define MAX31865_SENSOR_WIRES_0 2
//#define MAX31865_SENSOR_WIRES_1 2
//#define MAX31865_50HZ_FILTER

/**
 * Hephestos 2 24V heated bed upgrade kit.
 * https://store.bq.com/en/heated-bed-kit-hephestos2
 */
//#define HEPHESTOS2_HEATED_BED_KIT
#if ENABLED(HEPHESTOS2_HEATED_BED_KIT)
  #undef TEMP_SENSOR_BED
  #define TEMP_SENSOR_BED 70
  #define HEATER_BED_INVERTING true
#endif

//
// Heated Bed Bang-Bang options
//
#if DISABLED(PIDTEMPBED)
  #define BED_CHECK_INTERVAL 5000   // (ms) Interval between checks in bang-bang control
  #if ENABLED(BED_LIMIT_SWITCHING)
```

```
    #define BED_HYSTERESIS 2        // (°C) Only set the relevant heater state when ABS(T-target) > BED_HYSTERESIS
  #endif
#endif

//
// Heated Chamber options
//
#if DISABLED(PIDTEMPCHAMBER)
  #define CHAMBER_CHECK_INTERVAL 5000   // (ms) Interval between checks in bang-bang control
  #if ENABLED(CHAMBER_LIMIT_SWITCHING)
    #define CHAMBER_HYSTERESIS 2        // (°C) Only set the relevant heater state when ABS(T-target) > CHAMBER_HYSTERESIS
  #endif
#endif

#if TEMP_SENSOR_CHAMBER
  #define HEATER_CHAMBER_PIN      HEATER_1_PIN   // Required heater on/off pin (example: SKR 1.4 Turbo HE1 plug)
  //#define HEATER_CHAMBER_INVERTING false
  //#define FAN1_PIN                  -1   // Remove the fan signal on pin P2_04 (example: SKR 1.4 Turbo HE1 plug)

  //#define CHAMBER_FAN               // Enable a fan on the chamber
  #if ENABLED(CHAMBER_FAN)
    #define CHAMBER_FAN_MODE 2        // Fan control mode: 0=Static; 1=Linear increase when temp is higher than target; 2=V-shaped curve; 3=similar to 1 but fan is always on.
    #if CHAMBER_FAN_MODE == 0
      #define CHAMBER_FAN_BASE  255   // Chamber fan PWM (0-255)
    #elif CHAMBER_FAN_MODE == 1
      #define CHAMBER_FAN_BASE  128   // Base chamber fan PWM (0-255); turns on when chamber temperature is above the target
      #define CHAMBER_FAN_FACTOR 25   // PWM increase per °C above target
    #elif CHAMBER_FAN_MODE == 2
      #define CHAMBER_FAN_BASE  128   // Minimum chamber fan PWM (0-255)
      #define CHAMBER_FAN_FACTOR 25   // PWM increase per °C difference from target
    #elif CHAMBER_FAN_MODE == 3
      #define CHAMBER_FAN_BASE  128   // Base chamber fan PWM (0-255)
      #define CHAMBER_FAN_FACTOR 25   // PWM increase per °C above target
    #endif
  #endif

  //#define CHAMBER_VENT              // Enable a servo-controlled vent on the chamber
  #if ENABLED(CHAMBER_VENT)
    #define CHAMBER_VENT_SERVO_NR  1  // Index of the vent servo
    #define HIGH_EXCESS_HEAT_LIMIT 5  // How much above target temp to consider there is excess heat in the chamber
    #define LOW_EXCESS_HEAT_LIMIT  3
    #define MIN_COOLING_SLOPE_TIME_CHAMBER_VENT 20
    #define MIN_COOLING_SLOPE_DEG_CHAMBER_VENT 1.5
  #endif
#endif

//
// Laser Cooler options
```

```
// Laser cooler options
//
#if TEMP_SENSOR_COOLER
  #define COOLER_MINTEMP           8  // (°C)
  #define COOLER_MAXTEMP          26  // (°C)
  #define COOLER_DEFAULT_TEMP     16  // (°C)
  #define TEMP_COOLER_HYSTERESIS   1  // (°C) Temperature proximity considered "close enough" to the target
  #define COOLER_PIN               8  // Laser cooler on/off pin used to control power to the cooling element (e.g., TEC, External chiller via relay)
  #define COOLER_INVERTING     false
  #define TEMP_COOLER_PIN         15  // Laser/Cooler temperature sensor pin. ADC is required.
  #define COOLER_FAN                  // Enable a fan on the cooler, Fan# 0,1,2,3 etc.
  #define COOLER_FAN_INDEX         0  // FAN number 0, 1, 2 etc. e.g.
  #if ENABLED(COOLER_FAN)
    #define COOLER_FAN_BASE      100  // Base Cooler fan PWM (0-255); turns on when Cooler temperature is above the target
    #define COOLER_FAN_FACTOR     25  // PWM increase per °C above target
  #endif
#endif

//
// Motherboard Sensor options
//
#if TEMP_SENSOR_BOARD
  #define THERMAL_PROTECTION_BOARD   // Halt the printer if the board sensor leaves the temp range below.
  #define BOARD_MINTEMP            8  // (°C)
  #define BOARD_MAXTEMP           70  // (°C)
  #ifndef TEMP_BOARD_PIN
    //#define TEMP_BOARD_PIN -1      // Board temp sensor pin, if not set in pins file.
  #endif
#endif

//
// Laser Coolant Flow Meter
//
//#define LASER_COOLANT_FLOW_METER
#if ENABLED(LASER_COOLANT_FLOW_METER)
  #define FLOWMETER_PIN         20  // Requires an external interrupt-enabled pin (e.g., RAMPS 2,3,18,19,20,21)
  #define FLOWMETER_PPL       5880  // (pulses/liter) Flow meter pulses-per-liter on the input pin
  #define FLOWMETER_INTERVAL  1000  // (ms) Flow rate calculation interval in milliseconds
  #define FLOWMETER_SAFETY          // Prevent running the laser without the minimum flow rate set below
  #if ENABLED(FLOWMETER_SAFETY)
    #define FLOWMETER_MIN_LITERS_PER_MINUTE 1.5 // (liters/min) Minimum flow required when enabled
  #endif
#endif

/**
 * Thermal Protection provides additional protection to your printer from damage
```

```
 * and fire. Marlin always includes safe min and max temperature ranges which
 * protect against a broken or disconnected thermistor wire.
 *
 * The issue: If a thermistor falls out, it will report the much lower
 * temperature of the air in the room, and the the firmware will keep
 * the heater on.
 *
 * The solution: Once the temperature reaches the target, start observing.
 * If the temperature stays too far below the target (hysteresis) for too
 * long (period), the firmware will halt the machine as a safety precaution.
 *
 * If you get false positives for "Thermal Runaway", increase
 * THERMAL_PROTECTION_HYSTERESIS and/or THERMAL_PROTECTION_PERIOD
 */
#if ENABLED(THERMAL_PROTECTION_HOTENDS)
  #define THERMAL_PROTECTION_PERIOD 40        // Seconds
  #define THERMAL_PROTECTION_HYSTERESIS 4     // Degrees Celsius

  //#define ADAPTIVE_FAN_SLOWING              // Slow part cooling fan if temperature drops
  #if BOTH(ADAPTIVE_FAN_SLOWING, PIDTEMP)
    //#define NO_FAN_SLOWING_IN_PID_TUNING    // Don't slow fan speed during M303
  #endif

  /**
   * Whenever an M104, M109, or M303 increases the target temperature, the
   * firmware will wait for the WATCH_TEMP_PERIOD to expire. If the temperature
   * hasn't increased by WATCH_TEMP_INCREASE degrees, the machine is halted and
   * requires a hard reset. This test restarts with any M104/M109/M303, but only
   * if the current temperature is far enough below the target for a reliable
   * test.
   *
   * If you get false positives for "Heating failed", increase WATCH_TEMP_PERIOD
   * and/or decrease WATCH_TEMP_INCREASE. WATCH_TEMP_INCREASE should not be set
   * below 2.
   */
  #define WATCH_TEMP_PERIOD  20               // Seconds
  #define WATCH_TEMP_INCREASE 2               // Degrees Celsius
#endif

/**
 * Thermal Protection parameters for the bed are just as above for hotends.
 */
#if ENABLED(THERMAL_PROTECTION_BED)
  #define THERMAL_PROTECTION_BED_PERIOD        20 // Seconds
  #define THERMAL_PROTECTION_BED_HYSTERESIS     2 // Degrees Celsius

  /**
   * As described above, except for the bed (M140/M190/M303).
   */
  #define WATCH_BED_TEMP_PERIOD                60 // Seconds
```

```
  #define WATCH_BED_TEMP_INCREASE               2 // Degrees Celsius
#endif

/**
 * Thermal Protection parameters for the heated chamber.
 */
#if ENABLED(THERMAL_PROTECTION_CHAMBER)
  #define THERMAL_PROTECTION_CHAMBER_PERIOD    240 // Seconds
  #define THERMAL_PROTECTION_CHAMBER_HYSTERESIS 1 // Degrees Celsius

  /**
   * Heated chamber watch settings (M141/M191).
   */
  #define WATCH_CHAMBER_TEMP_PERIOD            240 // Seconds
  #define WATCH_CHAMBER_TEMP_INCREASE           1 // Degrees Celsius
#endif

/**
 * Thermal Protection parameters for the laser cooler.
 */
#if ENABLED(THERMAL_PROTECTION_COOLER)
  #define THERMAL_PROTECTION_COOLER_PERIOD    10 // Seconds
  #define THERMAL_PROTECTION_COOLER_HYSTERESIS 3 // Degrees Celsius

  /**
   * Laser cooling watch settings (M143/M193).
   */
  #define WATCH_COOLER_TEMP_PERIOD            60 // Seconds
  #define WATCH_COOLER_TEMP_INCREASE           3 // Degrees Celsius
#endif

#if ENABLED(PIDTEMP)
  // Add an experimental additional term to the heater power, proportional to the extrusion speed.
  // A well-chosen Kc value should add just enough power to melt the increased material volume.
  //#define PID_EXTRUSION_SCALING
  #if ENABLED(PID_EXTRUSION_SCALING)
    #define DEFAULT_Kc (100) // heating power = Kc * e_speed
    #define LPQ_MAX_LEN 50
  #endif

  /**
   * Add an experimental additional term to the heater power, proportional to the fan speed.
   * A well-chosen Kf value should add just enough power to compensate for power-loss from the cooling fan.
   * You can either just add a constant compensation with the DEFAULT_Kf value
   * or follow the instruction below to get speed-dependent compensation.
   *
   * Constant compensation (use only with fanspeeds of 0% and 100%)
   * -------------------------------------------------------------------
   * A good starting point for the Kf-value comes from the calculation:
   *   kf = (power_fan * eff_fan) / power_heater * 255
   * where eff_fan is between 0.0 and 1.0, based on fan-efficiency and airflow to the nozzle / heater.
   *
```

```
   * Example:
   *   Heater: 40W, Fan: 0.1A * 24V = 2.4W, eff_fan = 0.8
   *   Kf = (2.4W * 0.8) / 40W * 255 = 12.24
   *
   * Fan-speed dependent compensation
   * -------------------------------
   * 1. To find a good Kf value, set the hotend temperature, wait for it to settle, and enable the fan (100%).
   *    Make sure PID_FAN_SCALING_LIN_FACTOR is 0 and PID_FAN_SCALING_ALTERNATIVE_DEFINITION is not enabled.
   *    If you see the temperature drop repeat the test, increasing the Kf value slowly, until the temperature
   *    drop goes away. If the temperature overshoots after enabling the fan, the Kf value is too big.
   * 2. Note the Kf-value for fan-speed at 100%
   * 3. Determine a good value for PID_FAN_SCALING_MIN_SPEED, which is around the speed, where the fan starts moving.
   * 4. Repeat step 1. and 2. for this fan speed.
   * 5. Enable PID_FAN_SCALING_ALTERNATIVE_DEFINITION and enter the two identified Kf-values in
   *    PID_FAN_SCALING_AT_FULL_SPEED and PID_FAN_SCALING_AT_MIN_SPEED. Enter the minimum speed in PID_FAN_SCALING_MIN_SPEED
   */
  //#define PID_FAN_SCALING
  #if ENABLED(PID_FAN_SCALING)
    //#define PID_FAN_SCALING_ALTERNATIVE_DEFINITION
    #if ENABLED(PID_FAN_SCALING_ALTERNATIVE_DEFINITION)
      // The alternative definition is used for an easier configuration.
      // Just figure out Kf at fullspeed (255) and PID_FAN_SCALING_MIN_SPEED.
      // DEFAULT_Kf and PID_FAN_SCALING_LIN_FACTOR are calculated accordingly.

      #define PID_FAN_SCALING_AT_FULL_SPEED 13.0 //=PID_FAN_SCALING_LIN_FACTOR*255+DEFAULT_Kf
      #define PID_FAN_SCALING_AT_MIN_SPEED   6.0 //=PID_FAN_SCALING_LIN_FACTOR*PID_FAN_SCALING_MIN_SPEED+DEFAULT_Kf
      #define PID_FAN_SCALING_MIN_SPEED     10.0        // Minimum fan speed at which to enable PID_FAN_SCALING

      #define DEFAULT_Kf (255.0*PID_FAN_SCALING_AT_MIN_SPEED-PID_FAN_SCALING_AT_FULL_SPEED*PID_FAN_SCALING_MIN_SPEED)/(255.0-PID_FAN_SCALING_MIN_SPEED)
      #define PID_FAN_SCALING_LIN_FACTOR (PID_FAN_SCALING_AT_FULL_SPEED-DEFAULT_Kf)/255.0

    #else
      #define PID_FAN_SCALING_LIN_FACTOR (0)             // Power loss due to cooling = Kf * (fan_speed)
      #define DEFAULT_Kf 10                              // A constant value added to the PID-tuner
      #define PID_FAN_SCALING_MIN_SPEED 10               // Minimum fan speed at which to enable PID_FAN_SCALING
    #endif
  #endif
#endif

/**
 * Automatic Temperature Mode
```

```
 * Automatic Temperature Mode
 *
 * Dynamically adjust the hotend target temperature based on planned E moves.
 *
 * (Contrast with PID_EXTRUSION_SCALING, which tracks E movement and adjusts PID
 *  behavior using an additional kC value.)
 *
 * Autotemp is calculated by (mintemp + factor * mm_per_sec), capped to maxtemp.
 *
 * Enable Autotemp Mode with M104/M109 F<factor> S<mintemp> B<maxtemp>.
 * Disable by sending M104/M109 with no F parameter (or F0 with AUTOTEMP_PROPORTIONAL).
 */
#define AUTOTEMP
#if ENABLED(AUTOTEMP)
  #define AUTOTEMP_OLDWEIGHT    0.98
  // Turn on AUTOTEMP on M104/M109 by default using proportions set here
  //#define AUTOTEMP_PROPORTIONAL
  #if ENABLED(AUTOTEMP_PROPORTIONAL)
    #define AUTOTEMP_MIN_P      0 // (°C) Added to the target temperature
    #define AUTOTEMP_MAX_P      5 // (°C) Added to the target temperature
    #define AUTOTEMP_FACTOR_P   1 // Apply this F parameter by default (overridden by M104/M109 F)
  #endif
#endif

// Show Temperature ADC value
// Enable for M105 to include ADC values read from temperature sensors.
//#define SHOW_TEMP_ADC_VALUES

/**
 * High Temperature Thermistor Support
 *
 * Thermistors able to support high temperature tend to have a hard time getting
 * good readings at room and lower temperatures. This means TEMP_SENSOR_X_RAW_LO_TEMP
 * will probably be caught when the heating element first turns on during the
 * preheating process, which will trigger a min_temp_error as a safety measure
 * and force stop everything.
 * To circumvent this limitation, we allow for a preheat time (during which,
 * min_temp_error won't be triggered) and add a min_temp buffer to handle
 * aberrant readings.
 *
 * If you want to enable this feature for your hotend thermistor(s)
 * uncomment and set values > 0 in the constants below
 */

// The number of consecutive low temperature errors that can occur
// before a min_temp_error is triggered. (Shouldn't be more than 10.)
//#define MAX_CONSECUTIVE_LOW_TEMPERATURE_ERROR_ALLOWED 0

// The number of milliseconds a hotend will preheat before starting to check
// the temperature. This value should NOT be set to the time it takes the
```

```
// hot end to reach the target temperature, but the time it takes to reach
// the minimum temperature your thermistor can read. The lower the
better/safer.
// This shouldn't need to be more than 30 seconds (30000)
//#define MILLISECONDS_PREHEAT_TIME 0

// @section extruder

// Extruder runout prevention.
// If the machine is idle and the temperature over MINTEMP
// then extrude some filament every couple of SECONDS.
//#define EXTRUDER_RUNOUT_PREVENT
#if ENABLED(EXTRUDER_RUNOUT_PREVENT)
  #define EXTRUDER_RUNOUT_MINTEMP 190
  #define EXTRUDER_RUNOUT_SECONDS 30
  #define EXTRUDER_RUNOUT_SPEED 1500  // (mm/min)
  #define EXTRUDER_RUNOUT_EXTRUDE 5   // (mm)
#endif

/**
 * Hotend Idle Timeout
 * Prevent filament in the nozzle from charring and causing a critical jam.
 */
//#define HOTEND_IDLE_TIMEOUT
#if ENABLED(HOTEND_IDLE_TIMEOUT)
  #define HOTEND_IDLE_TIMEOUT_SEC (5*60)    // (seconds) Time without
extruder movement to trigger protection
  #define HOTEND_IDLE_MIN_TRIGGER   180     // (°C) Minimum temperature to
enable hotend protection
  #define HOTEND_IDLE_NOZZLE_TARGET   0     // (°C) Safe temperature for the
nozzle after timeout
  #define HOTEND_IDLE_BED_TARGET      0     // (°C) Safe temperature for the
bed after timeout
#endif

// @section temperature

// Calibration for AD595 / AD8495 sensor to adjust temperature measurements.
// The final temperature is calculated as (measuredTemp * GAIN) + OFFSET.
#define TEMP_SENSOR_AD595_OFFSET  0.0
#define TEMP_SENSOR_AD595_GAIN    1.0
#define TEMP_SENSOR_AD8495_OFFSET 0.0
#define TEMP_SENSOR_AD8495_GAIN   1.0

/**
 * Controller Fan
 * To cool down the stepper drivers and MOSFETs.
 *
 * The fan turns on automatically whenever any driver is enabled and turns
 * off (or reduces to idle speed) shortly after drivers are turned off.
 */
//#define USE_CONTROLLER_FAN
#if ENABLED(USE_CONTROLLER_FAN)
  //#define CONTROLLER_FAN_PIN -1           // Set a custom pin for the
controller fan
  //#define CONTROLLER_FAN_USE_Z_ONLY       // With this option only the Z
axis is considered
  //#define CONTROLLER_FAN_IGNORE_Z         // Ignore Z stepper. Useful when
stepper timeout is disabled
```

```
stepper timeout is disabled.
  #define CONTROLLERFAN_SPEED_MIN          0 // (0-255) Minimum speed. (If set below this value the fan is turned off.)
  #define CONTROLLERFAN_SPEED_ACTIVE     255 // (0-255) Active speed, used when any motor is enabled
  #define CONTROLLERFAN_SPEED_IDLE         0 // (0-255) Idle speed, used when motors are disabled
  #define CONTROLLERFAN_IDLE_TIME         60 // (seconds) Extra time to keep the fan running after disabling motors

  // Use TEMP_SENSOR_BOARD as a trigger for enabling the controller fan
  //#define CONTROLLER_FAN_MIN_BOARD_TEMP 40  // (°C) Turn on the fan if the board reaches this temperature

  //#define CONTROLLER_FAN_EDITABLE          // Enable M710 configurable settings
  #if ENABLED(CONTROLLER_FAN_EDITABLE)
    #define CONTROLLER_FAN_MENU            // Enable the Controller Fan submenu
  #endif
#endif

// When first starting the main fan, run it at full speed for the
// given number of milliseconds.  This gets the fan spinning reliably
// before setting a PWM value. (Does not work with software PWM for fan on Sanguinololu)
//#define FAN_KICKSTART_TIME 100

// Some coolers may require a non-zero "off" state.
//#define FAN_OFF_PWM  1

/**
 * PWM Fan Scaling
 *
 * Define the min/max speeds for PWM fans (as set with M106).
 *
 * With these options the M106 0-255 value range is scaled to a subset
 * to ensure that the fan has enough power to spin, or to run lower
 * current fans with higher current. (e.g., 5V/12V fans with 12V/24V)
 * Value 0 always turns off the fan.
 *
 * Define one or both of these to override the default 0-255 range.
 */
//#define FAN_MIN_PWM 50
//#define FAN_MAX_PWM 128

/**
 * FAST PWM FAN Settings
 *
 * Use to change the FAST FAN PWM frequency (if enabled in Configuration.h)
 * Combinations of PWM Modes, prescale values and TOP resolutions are used internally to produce a
 * frequency as close as possible to the desired frequency.
 *
 * FAST_PWM_FAN_FREQUENCY [undefined by default]
 *   Set this to your desired frequency.
 *   If left undefined this defaults to F = F_CPU/(2*255*1)
 *   i.e., F = 31.4kHz on 16MHz microcontrollers or F = 39.2kHz on 20MHz microcontrollers.
```

```
 *   These defaults are the same as with the old FAST_PWM_FAN implementation - no migration is required
 *   NOTE: Setting very low frequencies (< 10 Hz) may result in unexpected timer behavior.
 *
 * USE_OCR2A_AS_TOP [undefined by default]
 *   Boards that use TIMER2 for PWM have limitations resulting in only a few possible frequencies on TIMER2:
 *   16MHz MCUs: [62.5KHz, 31.4KHz (default), 7.8KHz, 3.92KHz, 1.95KHz, 977Hz, 488Hz, 244Hz, 60Hz, 122Hz, 30Hz]
 *   20MHz MCUs: [78.1KHz, 39.2KHz (default), 9.77KHz, 4.9KHz, 2.44KHz, 1.22KHz, 610Hz, 305Hz, 153Hz, 76Hz, 38Hz]
 *   A greater range can be achieved by enabling USE_OCR2A_AS_TOP. But note that this option blocks the use of
 *   PWM on pin OC2A. Only use this option if you don't need PWM on 0C2A. (Check your schematic.)
 *   USE_OCR2A_AS_TOP sacrifices duty cycle control resolution to achieve this broader range of frequencies.
 */
#if ENABLED(FAST_PWM_FAN)
  //#define FAST_PWM_FAN_FREQUENCY 31400
  //#define USE_OCR2A_AS_TOP
#endif

/**
 * Use one of the PWM fans as a redundant part-cooling fan
 */
//#define REDUNDANT_PART_COOLING_FAN 2  // Index of the fan to sync with FAN 0.

// @section extruder

/**
 * Extruder cooling fans
 *
 * Extruder auto fans automatically turn on when their extruders'
 * temperatures go above EXTRUDER_AUTO_FAN_TEMPERATURE.
 *
 * Your board's pins file specifies the recommended pins. Override those here
 * or set to -1 to disable completely.
 *
 * Multiple extruders can be assigned to the same pin in which case
 * the fan will turn on when any selected extruder is above the threshold.
 */
#define E0_AUTO_FAN_PIN -1
#define E1_AUTO_FAN_PIN -1
#define E2_AUTO_FAN_PIN -1
#define E3_AUTO_FAN_PIN -1
#define E4_AUTO_FAN_PIN -1
#define E5_AUTO_FAN_PIN -1
#define E6_AUTO_FAN_PIN -1
#define E7_AUTO_FAN_PIN -1
#define CHAMBER_AUTO_FAN_PIN -1
#define COOLER_AUTO_FAN_PIN -1
#define COOLER_FAN_PIN -1

#define EXTRUDER_AUTO_FAN_TEMPERATURE 50
#define EXTRUDER_AUTO_FAN_SPEED 255   // 255 == full speed
```

```
#define EXTRUDER_AUTO_FAN_SPEED 255   // 255 == full speed
#define CHAMBER_AUTO_FAN_TEMPERATURE 30
#define CHAMBER_AUTO_FAN_SPEED 255
#define COOLER_AUTO_FAN_TEMPERATURE 18
#define COOLER_AUTO_FAN_SPEED 255

/**
 * Part-Cooling Fan Multiplexer
 *
 * This feature allows you to digitally multiplex the fan output.
 * The multiplexer is automatically switched at tool-change.
 * Set FANMUX[012]_PINs below for up to 2, 4, or 8 multiplexed fans.
 */
#define FANMUX0_PIN -1
#define FANMUX1_PIN -1
#define FANMUX2_PIN -1

/**
 * M355 Case Light on-off / brightness
 */
//#define CASE_LIGHT_ENABLE
#if ENABLED(CASE_LIGHT_ENABLE)
  //#define CASE_LIGHT_PIN 4                  // Override the default pin if needed
  #define INVERT_CASE_LIGHT false             // Set true if Case Light is ON when pin is LOW
  #define CASE_LIGHT_DEFAULT_ON true          // Set default power-up state on
  #define CASE_LIGHT_DEFAULT_BRIGHTNESS 105   // Set default power-up brightness (0-255, requires PWM pin)
  //#define CASE_LIGHT_NO_BRIGHTNESS          // Disable brightness control. Enable for non-PWM lighting.
  //#define CASE_LIGHT_MAX_PWM 128            // Limit PWM duty cycle (0-255)
  //#define CASE_LIGHT_MENU                   // Add Case Light options to the LCD menu
  #if ENABLED(NEOPIXEL_LED)
    //#define CASE_LIGHT_USE_NEOPIXEL         // Use NeoPixel LED as case light
  #endif
  #if EITHER(RGB_LED, RGBW_LED)
    //#define CASE_LIGHT_USE_RGB_LED          // Use RGB / RGBW LED as case light
  #endif
  #if EITHER(CASE_LIGHT_USE_NEOPIXEL, CASE_LIGHT_USE_RGB_LED)
    #define CASE_LIGHT_DEFAULT_COLOR { 255, 255, 255, 255 } // { Red, Green, Blue, White }
  #endif
#endif

// @section homing

// If you want endstops to stay on (by default) even when not homing
// enable this option. Override at any time with M120, M121.
//#define ENDSTOPS_ALWAYS_ON_DEFAULT

// @section extras

//#define Z_LATE_ENABLE // Enable Z the last moment. Needed if your Z driver
```

```
overheats.

// Employ an external closed loop controller. Override pins here if needed.
//#define EXTERNAL_CLOSED_LOOP_CONTROLLER
#if ENABLED(EXTERNAL_CLOSED_LOOP_CONTROLLER)
  //#define CLOSED_LOOP_ENABLE_PIN        -1
  //#define CLOSED_LOOP_MOVE_COMPLETE_PIN -1
#endif

/**
 * Dual Steppers / Dual Endstops
 *
 * This section will allow you to use extra E drivers to drive a second motor for X, Y, or Z axes.
 *
 * For example, set X_DUAL_STEPPER_DRIVERS setting to use a second motor. If the motors need to
 * spin in opposite directions set INVERT_X2_VS_X_DIR. If the second motor needs its own endstop
 * set X_DUAL_ENDSTOPS. This can adjust for "racking." Use X2_USE_ENDSTOP to set the endstop plug
 * that should be used for the second endstop. Extra endstops will appear in the output of 'M119'.
 *
 * Use X_DUAL_ENDSTOP_ADJUSTMENT to adjust for mechanical imperfection. After homing both motors
 * this offset is applied to the X2 motor. To find the offset home the X axis, and measure the error
 * in X2. Dual endstop offsets can be set at runtime with 'M666 X<offset> Y<offset> Z<offset>'.
 */

//#define X_DUAL_STEPPER_DRIVERS
#if ENABLED(X_DUAL_STEPPER_DRIVERS)
  //#define INVERT_X2_VS_X_DIR    // Enable if X2 direction signal is opposite to X
  //#define X_DUAL_ENDSTOPS
  #if ENABLED(X_DUAL_ENDSTOPS)
    #define X2_USE_ENDSTOP _XMAX_
    #define X2_ENDSTOP_ADJUSTMENT  0
  #endif
#endif

//#define Y_DUAL_STEPPER_DRIVERS
#if ENABLED(Y_DUAL_STEPPER_DRIVERS)
  //#define INVERT_Y2_VS_Y_DIR   // Enable if Y2 direction signal is opposite to Y
  //#define Y_DUAL_ENDSTOPS
  #if ENABLED(Y_DUAL_ENDSTOPS)
    #define Y2_USE_ENDSTOP _YMAX_
    #define Y2_ENDSTOP_ADJUSTMENT  0
  #endif
#endif

//
// For Z set the number of stepper drivers
//
#define NUM_Z_STEPPER_DRIVERS 1   // (1-4) Z options change based on how
```

```
many

#if NUM_Z_STEPPER_DRIVERS > 1
  // Enable if Z motor direction signals are the opposite of Z1
  //#define INVERT_Z2_VS_Z_DIR
  //#define INVERT_Z3_VS_Z_DIR
  //#define INVERT_Z4_VS_Z_DIR

  //#define Z_MULTI_ENDSTOPS
  #if ENABLED(Z_MULTI_ENDSTOPS)
    #define Z2_USE_ENDSTOP          _XMAX_
    #define Z2_ENDSTOP_ADJUSTMENT   0
    #if NUM_Z_STEPPER_DRIVERS >= 3
      #define Z3_USE_ENDSTOP        _YMAX_
      #define Z3_ENDSTOP_ADJUSTMENT 0
    #endif
    #if NUM_Z_STEPPER_DRIVERS >= 4
      #define Z4_USE_ENDSTOP        _ZMAX_
      #define Z4_ENDSTOP_ADJUSTMENT 0
    #endif
  #endif
#endif

// Drive the E axis with two synchronized steppers
//#define E_DUAL_STEPPER_DRIVERS
#if ENABLED(E_DUAL_STEPPER_DRIVERS)
  //#define INVERT_E1_VS_E0_DIR   // Enable if the E motors need opposite
DIR states
#endif

/**
 * Dual X Carriage
 *
 * This setup has two X carriages that can move independently, each with its
own hotend.
 * The carriages can be used to print an object with two colors or
materials, or in
 * "duplication mode" it can print two identical or X-mirrored objects
simultaneously.
 * The inactive carriage is parked automatically to prevent oozing.
 * X1 is the left carriage, X2 the right. They park and home at opposite
ends of the X axis.
 * By default the X2 stepper is assigned to the first unused E plug on the
board.
 *
 * The following Dual X Carriage modes can be selected with M605 S<mode>:
 *
 *   0 : (FULL_CONTROL) The slicer has full control over both X-carriages
and can achieve optimal travel
 *       results as long as it supports dual X-carriages. (M605 S0)
 *
 *   1 : (AUTO_PARK) The firmware automatically parks and unparks the X-
carriages on tool-change so
 *       that additional slicer support is not required. (M605 S1)
 *
 *   2 : (DUPLICATION) The firmware moves the second X-carriage and extruder
in synchronization with
 *       the first X-carriage and extruder, to print 2 copies of the same
object at the same time.
```

```
 *       Set the constant X-offset and temperature differential with M605 S2 X[offs] R[deg] and
 *       follow with M605 S2 to initiate duplicated movement.
 *
 *   3 : (MIRRORED) Formbot/Vivedino-inspired mirrored mode in which the second extruder duplicates
 *       the movement of the first except the second extruder is reversed in the X axis.
 *       Set the initial X offset and temperature differential with M605 S2 X[offs] R[deg] and
 *       follow with M605 S3 to initiate mirrored movement.
 */
//#define DUAL_X_CARRIAGE
#if ENABLED(DUAL_X_CARRIAGE)
  #define X1_MIN_POS X_MIN_POS   // Set to X_MIN_POS
  #define X1_MAX_POS X_BED_SIZE  // Set a maximum so the first X-carriage can't hit the parked second X-carriage
  #define X2_MIN_POS    80       // Set a minimum to ensure the  second X-carriage can't hit the parked first X-carriage
  #define X2_MAX_POS   353       // Set this to the distance between toolheads when both heads are homed
  #define X2_HOME_DIR    1       // Set to 1. The second X-carriage always homes to the maximum endstop position
  #define X2_HOME_POS X2_MAX_POS // Default X2 home position. Set to X2_MAX_POS.
                       // However: In this mode the HOTEND_OFFSET_X value for the second extruder provides a software
                       // override for X2_HOME_POS. This also allow recalibration of the distance between the two endstops
                       // without modifying the firmware (through the "M218 T1 X???" command).
                       // Remember: you should set the second extruder x-offset to 0 in your slicer.

  // This is the default power-up mode which can be later using M605.
  #define DEFAULT_DUAL_X_CARRIAGE_MODE DXC_AUTO_PARK_MODE

  // Default x offset in duplication mode (typically set to half print bed width)
  #define DEFAULT_DUPLICATION_X_OFFSET 100

  // Default action to execute following M605 mode change commands. Typically G28X to apply new mode.
  //#define EVENT_GCODE_IDEX_AFTER_MODECHANGE "G28X"
#endif

// Activate a solenoid on the active extruder with M380. Disable all with M381.
// Define SOL0_PIN, SOL1_PIN, etc., for each extruder that has a solenoid.
//#define EXT_SOLENOID

// @section homing

/**
 * Homing Procedure
 * Homing (G28) does an indefinite move towards the endstops to establish
 * the position of the toolhead relative to the workspace.
 */
```

```
//#define SENSORLESS_BACKOFF_MM  { 2, 2, 0 }  // (mm) Backoff from endstops before sensorless homing

#define HOMING_BUMP_MM      { 5, 5, 2 }       // (mm) Backoff from endstops after first bump
#define HOMING_BUMP_DIVISOR { 2, 2, 4 }       // Re-Bump Speed Divisor (Divides the Homing Feedrate)

//#define HOMING_BACKOFF_POST_MM { 2, 2, 2 }  // (mm) Backoff from endstops after homing

//#define QUICK_HOME                          // If G28 contains XY do a diagonal move first
//#define HOME_Y_BEFORE_X                     // If G28 contains XY home Y before X
//#define HOME_Z_FIRST                        // Home Z first. Requires a Z-MIN endstop (not a probe).
//#define CODEPENDENT_XY_HOMING               // If X/Y can't home without homing Y/X first

// @section bltouch

#if ENABLED(BLTOUCH)
  /**
   * Either: Use the defaults (recommended) or: For special purposes, use the following DEFINES
   * Do not activate settings that the probe might not understand. Clones might misunderstand
   * advanced commands.
   *
   * Note: If the probe is not deploying, do a "Reset" and "Self-Test" and then check the
   *       wiring of the BROWN, RED and ORANGE wires.
   *
   * Note: If the trigger signal of your probe is not being recognized, it has been very often
   *       because the BLACK and WHITE wires needed to be swapped. They are not "interchangeable"
   *       like they would be with a real switch. So please check the wiring first.
   *
   * Settings for all BLTouch and clone probes:
   */

  // Safety: The probe needs time to recognize the command.
  //         Minimum command delay (ms). Enable and increase if needed.
  //#define BLTOUCH_DELAY 500

  /**
   * Settings for BLTOUCH Classic 1.2, 1.3 or BLTouch Smart 1.0, 2.0, 2.2, 3.0, 3.1, and most clones:
   */

  // Feature: Switch into SW mode after a deploy. It makes the output pulse longer. Can be useful
  //          in special cases, like noisy or filtered input configurations.
  //#define BLTOUCH_FORCE_SW_MODE

```

```
  /**
   * Settings for BLTouch Smart 3.0 and 3.1
   * Summary:
   *   - Voltage modes: 5V and OD (open drain - "logic voltage free") output modes
   *   - High-Speed mode
   *   - Disable LCD voltage options
   */

  /**
   * Danger: Don't activate 5V mode unless attached to a 5V-tolerant controller!
   * V3.0 or 3.1: Set default mode to 5V mode at Marlin startup.
   * If disabled, OD mode is the hard-coded default on 3.0
   * On startup, Marlin will compare its eeprom to this value. If the selected mode
   * differs, a mode set eeprom write will be completed at initialization.
   * Use the option below to force an eeprom write to a V3.1 probe regardless.
   */
  //#define BLTOUCH_SET_5V_MODE

  /**
   * Safety: Activate if connecting a probe with an unknown voltage mode.
   * V3.0: Set a probe into mode selected above at Marlin startup. Required for 5V mode on 3.0
   * V3.1: Force a probe with unknown mode into selected mode at Marlin startup ( = Probe EEPROM write )
   * To preserve the life of the probe, use this once then turn it off and re-flash.
   */
  //#define BLTOUCH_FORCE_MODE_SET

  /**
   * Use "HIGH SPEED" mode for probing.
   * Danger: Disable if your probe sometimes fails. Only suitable for stable well-adjusted systems.
   * This feature was designed for Deltabots with very fast Z moves; however, higher speed Cartesians
   * might be able to use it. If the machine can't raise Z fast enough the BLTouch may go into ALARM.
   */
  //#define BLTOUCH_HS_MODE

  // Safety: Enable voltage mode settings in the LCD menu.
  //#define BLTOUCH_LCD_VOLTAGE_MENU

#endif // BLTOUCH

// @section extras

/**
 * Z Steppers Auto-Alignment
 * Add the G34 command to align multiple Z steppers using a bed probe.
 */
//#define Z_STEPPER_AUTO_ALIGN
#if ENABLED(Z_STEPPER_AUTO_ALIGN)
  // Define probe X and Y positions for Z1, Z2 [, Z3 [, Z4]]
```

```
  // If not defined, probe limits will be used.
  // Override with 'M422 S<index> X<pos> Y<pos>'
  //#define Z_STEPPER_ALIGN_XY { {  10, 190 }, { 100,  10 }, { 190, 190 } }

  /**
   * Orientation for the automatically-calculated probe positions.
   * Override Z stepper align points with 'M422 S<index> X<pos> Y<pos>'
   *
   * 2 Steppers:  (0)     (1)
   *               |       |   2   |
   *               | 1   2 |       |
   *               |       |   1   |
   *
   * 3 Steppers:  (0)     (1)     (2)     (3)
   *               |   3   | 1     | 2   1 |     2 |
   *               |       |     3 |       | 3     |
   *               | 1   2 | 2     |   3   |     1 |
   *
   * 4 Steppers:  (0)     (1)     (2)     (3)
   *               | 4   3 | 1   4 | 2   1 | 3   2 |
   *               |       |       |       |       |
   *               | 1   2 | 2   3 | 3   4 | 4   1 |
   */
  #ifndef Z_STEPPER_ALIGN_XY
    //#define Z_STEPPERS_ORIENTATION 0
  #endif

  // Provide Z stepper positions for more rapid convergence in bed alignment.
  // Requires triple stepper drivers (i.e., set NUM_Z_STEPPER_DRIVERS to 3)
  //#define Z_STEPPER_ALIGN_KNOWN_STEPPER_POSITIONS
  #if ENABLED(Z_STEPPER_ALIGN_KNOWN_STEPPER_POSITIONS)
    // Define Stepper XY positions for Z1, Z2, Z3 corresponding to
    // the Z screw positions in the bed carriage.
    // Define one position per Z stepper in stepper driver order.
    #define Z_STEPPER_ALIGN_STEPPER_XY { { 210.7, 102.5 }, { 152.6, 220.0 }, { 94.5, 102.5 } }
  #else
    // Amplification factor. Used to scale the correction step up or down in case
    // the stepper (spindle) position is farther out than the test point.
    #define Z_STEPPER_ALIGN_AMP 1.0       // Use a value > 1.0 NOTE: This may cause instability!
  #endif

  // On a 300mm bed a 5% grade would give a misalignment of ~1.5cm
  #define G34_MAX_GRADE             5    // (%) Maximum incline that G34 will handle
  #define Z_STEPPER_ALIGN_ITERATIONS 5    // Number of iterations to apply during alignment
  #define Z_STEPPER_ALIGN_ACC       0.02 // Stop iterating early if the accuracy is better than this
  #define RESTORE_LEVELING_AFTER_G34      // Restore leveling after G34 is done?
  // After G34, re-home Z (G28 Z) or just calculate it from the last probe heights?
  // Re-homing might be more precise in reproducing the actual 'G28 Z' homing height, especially on an uneven bed.
  #define HOME_AFTER_G34
```

```
#endif

//
// Add the G35 command to read bed corners to help adjust screws. Requires a bed probe.
//
//#define ASSISTED_TRAMMING
#if ENABLED(ASSISTED_TRAMMING)

  // Define positions for probe points.
  #define TRAMMING_POINT_XY { {  20, 20 }, { 180,  20 }, { 180, 180 }, { 20, 180 } }

  // Define position names for probe points.
  #define TRAMMING_POINT_NAME_1 "Front-Left"
  #define TRAMMING_POINT_NAME_2 "Front-Right"
  #define TRAMMING_POINT_NAME_3 "Back-Right"
  #define TRAMMING_POINT_NAME_4 "Back-Left"

  #define RESTORE_LEVELING_AFTER_G35    // Enable to restore leveling setup after operation
  //#define REPORT_TRAMMING_MM          // Report Z deviation (mm) for each point relative to the first

  //#define ASSISTED_TRAMMING_WIZARD    // Add a Tramming Wizard to the LCD menu

  //#define ASSISTED_TRAMMING_WAIT_POSITION { X_CENTER, Y_CENTER, 30 } // Move the nozzle out of the way for adjustment

  /**
   * Screw thread:
   *   M3: 30 = Clockwise, 31 = Counter-Clockwise
   *   M4: 40 = Clockwise, 41 = Counter-Clockwise
   *   M5: 50 = Clockwise, 51 = Counter-Clockwise
   */
  #define TRAMMING_SCREW_THREAD 30

#endif

// @section motion

#define AXIS_RELATIVE_MODES { false, false, false, false }

// Add a Duplicate option for well-separated conjoined nozzles
//#define MULTI_NOZZLE_DUPLICATION

// By default pololu step drivers require an active high signal. However, some high power drivers require an active low signal as step.
#define INVERT_X_STEP_PIN false
#define INVERT_Y_STEP_PIN false
#define INVERT_Z_STEP_PIN false
#define INVERT_I_STEP_PIN false
#define INVERT_J_STEP_PIN false
#define INVERT_K_STEP_PIN false
#define INVERT_E_STEP_PIN false

/**
```

```
 * Idle Stepper Shutdown
 * Set DISABLE_INACTIVE_? 'true' to shut down axis steppers after an idle period.
 * The Deactive Time can be overridden with M18 and M84. Set to 0 for No Timeout.
 */
#define DEFAULT_STEPPER_DEACTIVE_TIME 120
#define DISABLE_INACTIVE_X true
#define DISABLE_INACTIVE_Y true
#define DISABLE_INACTIVE_Z true  // Set 'false' if the nozzle could fall onto your printed part!
#define DISABLE_INACTIVE_I true
#define DISABLE_INACTIVE_J true
#define DISABLE_INACTIVE_K true
#define DISABLE_INACTIVE_E true

// Default Minimum Feedrates for printing and travel moves
#define DEFAULT_MINIMUMFEEDRATE       0.0     // (mm/s) Minimum feedrate. Set with M205 S.
#define DEFAULT_MINTRAVELFEEDRATE     0.0     // (mm/s) Minimum travel feedrate. Set with M205 T.

// Minimum time that a segment needs to take as the buffer gets emptied
#define DEFAULT_MINSEGMENTTIME        20000   // (µs) Set with M205 B.

// Slow down the machine if the lookahead buffer is (by default) half full.
// Increase the slowdown divisor for larger buffer sizes.
#define SLOWDOWN
#if ENABLED(SLOWDOWN)
  #define SLOWDOWN_DIVISOR 2
#endif

/**
 * XY Frequency limit
 * Reduce resonance by limiting the frequency of small zigzag infill moves.
 * See https://hydraraptor.blogspot.com/2010/12/frequency-limit.html
 * Use M201 F<freq> G<min%> to change limits at runtime.
 */
//#define XY_FREQUENCY_LIMIT      10 // (Hz) Maximum frequency of small zigzag infill moves. Set with M201 F<hertz>.
#ifdef XY_FREQUENCY_LIMIT
  #define XY_FREQUENCY_MIN_PERCENT 5 // (percent) Minimum FR percentage to apply. Set with M201 G<min%>.
#endif

// Minimum planner junction speed. Sets the default minimum speed the planner plans for at the end
// of the buffer and all stops. This should not be much greater than zero and should only be changed
// if unwanted behavior is observed on a user's machine when running at very slow speeds.
#define MINIMUM_PLANNER_SPEED 0.05 // (mm/s)

//
// Backlash Compensation
// Adds extra movement to axes on direction-changes to account for backlash.
//
//#define BACKLASH_COMPENSATION
#if ENABLED(BACKLASH_COMPENSATION)
```

```
  // Define values for backlash distance and correction.
  // If BACKLASH_GCODE is enabled these values are the defaults.
  #define BACKLASH_DISTANCE_MM { 0, 0, 0 } // (mm) One value for each linear axis
  #define BACKLASH_CORRECTION    0.0       // 0.0 = no correction; 1.0 = full correction

  // Add steps for motor direction changes on CORE kinematics
  //#define CORE_BACKLASH

  // Set BACKLASH_SMOOTHING_MM to spread backlash correction over multiple segments
  // to reduce print artifacts. (Enabling this is costly in memory and computation!)
  //#define BACKLASH_SMOOTHING_MM 3 // (mm)

  // Add runtime configuration and tuning of backlash values (M425)
  //#define BACKLASH_GCODE

  #if ENABLED(BACKLASH_GCODE)
    // Measure the Z backlash when probing (G29) and set with "M425 Z"
    #define MEASURE_BACKLASH_WHEN_PROBING

    #if ENABLED(MEASURE_BACKLASH_WHEN_PROBING)
      // When measuring, the probe will move up to BACKLASH_MEASUREMENT_LIMIT
      // mm away from point of contact in BACKLASH_MEASUREMENT_RESOLUTION
      // increments while checking for the contact to be broken.
      #define BACKLASH_MEASUREMENT_LIMIT       0.5   // (mm)
      #define BACKLASH_MEASUREMENT_RESOLUTION  0.005 // (mm)
      #define BACKLASH_MEASUREMENT_FEEDRATE    Z_PROBE_FEEDRATE_SLOW // (mm/min)
    #endif
  #endif
#endif

/**
 * Automatic backlash, position and hotend offset calibration
 *
 * Enable G425 to run automatic calibration using an electrically-
 * conductive cube, bolt, or washer mounted on the bed.
 *
 * G425 uses the probe to touch the top and sides of the calibration object
 * on the bed and measures and/or correct positional offsets, axis backlash
 * and hotend offsets.
 *
 * Note: HOTEND_OFFSET and CALIBRATION_OBJECT_CENTER must be set to within
 *       ±5mm of true values for G425 to succeed.
 */
//#define CALIBRATION_GCODE
#if ENABLED(CALIBRATION_GCODE)

  //#define CALIBRATION_SCRIPT_PRE  "M117 Starting Auto-Calibration\nT0\nG28\nG12\nM117 Calibrating..."
  //#define CALIBRATION_SCRIPT_POST "M500\nM117 Calibration data saved"

  #define CALIBRATION_MEASUREMENT_RESOLUTION     0.01 // mm
```

```
  #define CALIBRATION_FEEDRATE_SLOW             60    // mm/min
  #define CALIBRATION_FEEDRATE_FAST           1200    // mm/min
  #define CALIBRATION_FEEDRATE_TRAVEL         3000    // mm/min

  // The following parameters refer to the conical section of the nozzle tip.
  #define CALIBRATION_NOZZLE_TIP_HEIGHT          1.0  // mm
  #define CALIBRATION_NOZZLE_OUTER_DIAMETER      2.0  // mm

  // Uncomment to enable reporting (required for "G425 V", but consumes PROGMEM).
  //#define CALIBRATION_REPORTING

  // The true location and dimension the cube/bolt/washer on the bed.
  #define CALIBRATION_OBJECT_CENTER     { 264.0, -22.0,  -2.0 } // mm
  #define CALIBRATION_OBJECT_DIMENSIONS {  10.0,  10.0,  10.0 } // mm

  // Comment out any sides which are unreachable by the probe. For best
  // auto-calibration results, all sides must be reachable.
  #define CALIBRATION_MEASURE_RIGHT
  #define CALIBRATION_MEASURE_FRONT
  #define CALIBRATION_MEASURE_LEFT
  #define CALIBRATION_MEASURE_BACK

  //#define CALIBRATION_MEASURE_IMIN
  //#define CALIBRATION_MEASURE_IMAX
  //#define CALIBRATION_MEASURE_JMIN
  //#define CALIBRATION_MEASURE_JMAX
  //#define CALIBRATION_MEASURE_KMIN
  //#define CALIBRATION_MEASURE_KMAX

  // Probing at the exact top center only works if the center is flat. If
  // probing on a screwhead or hollow washer, probe near the edges.
  //#define CALIBRATION_MEASURE_AT_TOP_EDGES

  // Define the pin to read during calibration
  #ifndef CALIBRATION_PIN
    //#define CALIBRATION_PIN -1           // Define here to override the default pin
    #define CALIBRATION_PIN_INVERTING false // Set to true to invert the custom pin
    //#define CALIBRATION_PIN_PULLDOWN
    #define CALIBRATION_PIN_PULLUP
  #endif
#endif

/**
 * Adaptive Step Smoothing increases the resolution of multi-axis moves, particularly at step frequencies
 * below 1kHz (for AVR) or 10kHz (for ARM), where aliasing between axes in multi-axis moves causes audible
 * vibration and surface artifacts. The algorithm adapts to provide the best possible step smoothing at the
 * lowest stepping frequencies.
 */
//#define ADAPTIVE_STEP_SMOOTHING

/**
 * Custom Microstepping
```

```
 * Override as-needed for your setup. Up to 3 MS pins are supported.
 */
//#define MICROSTEP1 LOW,LOW,LOW
//#define MICROSTEP2 HIGH,LOW,LOW
//#define MICROSTEP4 LOW,HIGH,LOW
//#define MICROSTEP8 HIGH,HIGH,LOW
//#define MICROSTEP16 LOW,LOW,HIGH
//#define MICROSTEP32 HIGH,LOW,HIGH

// Microstep settings (Requires a board with pins named X_MS1, X_MS2, etc.)
#define MICROSTEP_MODES { 16, 16, 16, 16, 16, 16 } // [1,2,4,8,16]

/**
 *  @section  stepper motor current
 *
 *  Some boards have a means of setting the stepper motor current via firmware.
 *
 *  The power on motor currents are set by:
 *    PWM_MOTOR_CURRENT - used by MINIRAMBO & ULTIMAIN_2
 *                        known compatible chips: A4982
 *    DIGIPOT_MOTOR_CURRENT - used by BQ_ZUM_MEGA_3D, RAMBO & SCOOVO_X9H
 *                        known compatible chips: AD5206
 *    DAC_MOTOR_CURRENT_DEFAULT - used by PRINTRBOARD_REVF & RIGIDBOARD_V2
 *                        known compatible chips: MCP4728
 *    DIGIPOT_I2C_MOTOR_CURRENTS - used by 5DPRINT, AZTEEG_X3_PRO, AZTEEG_X5_MINI_WIFI, MIGHTYBOARD_REVE
 *                        known compatible chips: MCP4451, MCP4018
 *
 *  Motor currents can also be set by M907 - M910 and by the LCD.
 *    M907 - applies to all.
 *    M908 - BQ_ZUM_MEGA_3D, RAMBO, PRINTRBOARD_REVF, RIGIDBOARD_V2 & SCOOVO_X9H
 *    M909, M910 & LCD - only PRINTRBOARD_REVF & RIGIDBOARD_V2
 */
//#define PWM_MOTOR_CURRENT { 1300, 1300, 1250 }          // Values in milliamps
//#define DIGIPOT_MOTOR_CURRENT { 135,135,135,135,135 }   // Values 0-255 (RAMBO 135 = ~0.75A, 185 = ~1A)
//#define DAC_MOTOR_CURRENT_DEFAULT { 70, 80, 90, 80 }    // Default drive percent - X, Y, Z, E axis

/**
 * I2C-based DIGIPOTs (e.g., Azteeg X3 Pro)
 */
//#define DIGIPOT_MCP4018            // Requires https://github.com/felias-fogg/SlowSoftI2CMaster
//#define DIGIPOT_MCP4451
#if EITHER(DIGIPOT_MCP4018, DIGIPOT_MCP4451)
  #define DIGIPOT_I2C_NUM_CHANNELS 8  // 5DPRINT:4   AZTEEG_X3_PRO:8   MKS_SBASE:5   MIGHTYBOARD_REVE:5

  // Actual motor currents in Amps. The number of entries must match DIGIPOT_I2C_NUM_CHANNELS.
  // These correspond to the physical drivers, so be mindful if the order is changed.
  #define DIGIPOT_I2C_MOTOR_CURRENTS { 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 } // AZTEEG_X3_PRO
```

```
1176
1177  //#define DIGIPOT_USE_RAW_VALUES    // Use DIGIPOT_MOTOR_CURRENT raw wiper values (instead of A4988 motor currents)
1178
1179  /**
1180   * Common slave addresses:
1181   *
1182   *                        A   (A shifted)   B   (B shifted)  IC
1183   * Smoothie             0x2C (0x58)       0x2D (0x5A)       MCP4451
1184   * AZTEEG_X3_PRO        0x2C (0x58)       0x2E (0x5C)       MCP4451
1185   * AZTEEG_X5_MINI       0x2C (0x58)       0x2E (0x5C)       MCP4451
1186   * AZTEEG_X5_MINI_WIFI         0x58              0x5C       MCP4451
1187   * MIGHTYBOARD_REVE     0x2F (0x5E)                         MCP4018
1188   */
1189  //#define DIGIPOT_I2C_ADDRESS_A 0x2C  // Unshifted slave address for first DIGIPOT
1190  //#define DIGIPOT_I2C_ADDRESS_B 0x2D  // Unshifted slave address for second DIGIPOT
1191 #endif
1192
1193 //===========================================================================
1194 //=============================Additional Features===========================
1195 //===========================================================================
1196
1197 // @section lcd
1198
1199 #if ANY(HAS_LCD_MENU, EXTENSIBLE_UI, HAS_DWIN_E3V2)
1200   #define MANUAL_FEEDRATE { 50*60, 50*60, 4*60, 2*60 } // (mm/min) Feedrates for manual moves along X, Y, Z, E from panel
1201   #define FINE_MANUAL_MOVE 0.025    // (mm) Smallest manual move (< 0.1mm) applying to Z on most machines
1202   #if IS_ULTIPANEL
1203     #define MANUAL_E_MOVES_RELATIVE // Display extruder move distance rather than "position"
1204     #define ULTIPANEL_FEEDMULTIPLY  // Encoder sets the feedrate multiplier on the Status Screen
1205   #endif
1206 #endif
1207
1208 // Change values more rapidly when the encoder is rotated faster
1209 #define ENCODER_RATE_MULTIPLIER
1210 #if ENABLED(ENCODER_RATE_MULTIPLIER)
1211   #define ENCODER_10X_STEPS_PER_SEC   30  // (steps/s) Encoder rate for 10x speed
1212   #define ENCODER_100X_STEPS_PER_SEC  80  // (steps/s) Encoder rate for 100x speed
1213 #endif
1214
1215 // Play a beep when the feedrate is changed from the Status Screen
1216 //#define BEEP_ON_FEEDRATE_CHANGE
1217 #if ENABLED(BEEP_ON_FEEDRATE_CHANGE)
1218   #define FEEDRATE_CHANGE_BEEP_DURATION   10
1219   #define FEEDRATE_CHANGE_BEEP_FREQUENCY 440
1220 #endif
1221
1222 #if HAS_LCD_MENU
```

```
#if HAS_LCD_MENU

  // Add Probe Z Offset calibration to the Z Probe Offsets menu
  #if HAS_BED_PROBE
    //#define PROBE_OFFSET_WIZARD
    #if ENABLED(PROBE_OFFSET_WIZARD)
      //
      // Enable to init the Probe Z-Offset when starting the Wizard.
      // Use a height slightly above the estimated nozzle-to-probe Z offset.
      // For example, with an offset of -5, consider a starting height of -4.
      //
      //#define PROBE_OFFSET_WIZARD_START_Z -4.0

      // Set a convenient position to do the calibration (probing point and nozzle/bed-distance)
      //#define PROBE_OFFSET_WIZARD_XY_POS { X_CENTER, Y_CENTER }
    #endif
  #endif

  // Include a page of printer information in the LCD Main Menu
  //#define LCD_INFO_MENU
  #if ENABLED(LCD_INFO_MENU)
    //#define LCD_PRINTER_INFO_IS_BOOTSCREEN // Show bootscreen(s) instead of Printer Info pages
  #endif

  // BACK menu items keep the highlight at the top
  //#define TURBO_BACK_MENU_ITEM

  // Add a mute option to the LCD menu
  //#define SOUND_MENU_ITEM

  /**
   * LED Control Menu
   * Add LED Control to the LCD menu
   */
  //#define LED_CONTROL_MENU
  #if ENABLED(LED_CONTROL_MENU)
    #define LED_COLOR_PRESETS                 // Enable the Preset Color menu option
    //#define NEO2_COLOR_PRESETS              // Enable a second NeoPixel Preset Color menu option
    #if ENABLED(LED_COLOR_PRESETS)
      #define LED_USER_PRESET_RED        255  // User defined RED value
      #define LED_USER_PRESET_GREEN      128  // User defined GREEN value
      #define LED_USER_PRESET_BLUE         0  // User defined BLUE value
      #define LED_USER_PRESET_WHITE      255  // User defined WHITE value
      #define LED_USER_PRESET_BRIGHTNESS 255  // User defined intensity
      //#define LED_USER_PRESET_STARTUP       // Have the printer display the user preset color on startup
    #endif
    #if ENABLED(NEO2_COLOR_PRESETS)
      #define NEO2_USER_PRESET_RED        255  // User defined RED value
      #define NEO2_USER_PRESET_GREEN      128  // User defined GREEN value
      #define NEO2_USER_PRESET_BLUE         0  // User defined BLUE value
      #define NEO2_USER_PRESET_WHITE      255  // User defined WHITE value
      #define NEO2_USER_PRESET_BRIGHTNESS 255  // User defined intensity
      //#define NEO2_USER_PRESET_STARTUP       // Have the printer display
```

```
the user preset color on startup for the second strip
    #endif
  #endif

  // Insert a menu for preheating at the top level to allow for quick access
  //#define PREHEAT_SHORTCUT_MENU_ITEM

#endif // HAS_LCD_MENU

#if HAS_DISPLAY
  // The timeout (in ms) to return to the status screen from sub-menus
  //#define LCD_TIMEOUT_TO_STATUS 15000

  #if ENABLED(SHOW_BOOTSCREEN)
    #define BOOTSCREEN_TIMEOUT 4000      // (ms) Total Duration to display the boot screen(s)
    #if EITHER(HAS_MARLINUI_U8GLIB, TFT_COLOR_UI)
      #define BOOT_MARLIN_LOGO_SMALL     // Show a smaller Marlin logo on the Boot Screen (saving lots of flash)
    #endif
  #endif

  // Scroll a longer status message into view
  //#define STATUS_MESSAGE_SCROLLING

  // On the Info Screen, display XY with one decimal place when possible
  //#define LCD_DECIMAL_SMALL_XY

  // Add an 'M73' G-code to set the current percentage
  //#define LCD_SET_PROGRESS_MANUALLY

  // Show the E position (filament used) during printing
  //#define LCD_SHOW_E_TOTAL
#endif

// LCD Print Progress options
#if EITHER(SDSUPPORT, LCD_SET_PROGRESS_MANUALLY)
  #if ANY(HAS_MARLINUI_U8GLIB, EXTENSIBLE_UI, HAS_MARLINUI_HD44780, IS_TFTGLCD_PANEL, IS_DWIN_MARLINUI)
    //#define SHOW_REMAINING_TIME         // Display estimated time to completion
    #if ENABLED(SHOW_REMAINING_TIME)
      //#define USE_M73_REMAINING_TIME    // Use remaining time from M73 command instead of estimation
      //#define ROTATE_PROGRESS_DISPLAY   // Display (P)rogress, (E)lapsed, and (R)emaining time
    #endif
  #endif

  #if EITHER(HAS_MARLINUI_U8GLIB, EXTENSIBLE_UI)
    //#define PRINT_PROGRESS_SHOW_DECIMALS // Show progress with decimal digits
  #endif

  #if EITHER(HAS_MARLINUI_HD44780, IS_TFTGLCD_PANEL)
    //#define LCD_PROGRESS_BAR            // Show a progress bar on HD44780 LCDs for SD printing
    #if ENABLED(LCD_PROGRESS_BAR)
      #define PROGRESS_BAR_BAR_TIME 2000  // (ms) Amount of time to show the
```

```
      #define PROGRESS_BAR_BAR_TIME 2000  // (ms) Amount of time to show the
bar
      #define PROGRESS_BAR_MSG_TIME 3000  // (ms) Amount of time to show the
status message
      #define PROGRESS_MSG_EXPIRE   0     // (ms) Amount of time to retain
the status message (0=forever)
      //#define PROGRESS_MSG_ONCE         // Show the message for MSG_TIME
then clear it
      //#define LCD_PROGRESS_BAR_TEST     // Add a menu item to test the
progress bar
    #endif
  #endif
#endif

#if ENABLED(SDSUPPORT)
  /**
   * SD Card SPI Speed
   * May be required to resolve "volume init" errors.
   *
   * Enable and set to SPI_HALF_SPEED, SPI_QUARTER_SPEED, or
SPI_EIGHTH_SPEED
   *  otherwise full speed will be applied.
   *
   * :['SPI_HALF_SPEED', 'SPI_QUARTER_SPEED', 'SPI_EIGHTH_SPEED']
   */
  //#define SD_SPI_SPEED SPI_HALF_SPEED

  // The standard SD detect circuit reads LOW when media is inserted and
HIGH when empty.
  // Enable this option and set to HIGH if your SD cards are incorrectly
detected.
  //#define SD_DETECT_STATE HIGH

  //#define SD_IGNORE_AT_STARTUP            // Don't mount the SD card when
starting up
  //#define SDCARD_READONLY                 // Read-only SD card (to save
over 2K of flash)

  //#define GCODE_REPEAT_MARKERS            // Enable G-code M808 to set
repeat markers and do looping

  #define SD_PROCEDURE_DEPTH 1              // Increase if you need more
nested M32 calls

  #define SD_FINISHED_STEPPERRELEASE true   // Disable steppers when SD
Print is finished
  #define SD_FINISHED_RELEASECOMMAND "M84"  // Use "M84XYE" to keep Z
enabled so your bed stays in place

  // Reverse SD sort to show "more recent" files first, according to the
card's FAT.
  // Since the FAT gets out of order with usage, SDCARD_SORT_ALPHA is
recommended.
  #define SDCARD_RATHERRECENTFIRST

  #define SD_MENU_CONFIRM_START             // Confirm the selected SD file
before printing

  //#define NO_SD_AUTOSTART                 // Remove auto#.g file support
```

```
completely to save some Flash, SRAM
1366   //#define MENU_ADDAUTOSTART              // Add a menu option to run auto#.g files
1367
1368   //#define BROWSE_MEDIA_ON_INSERT         // Open the file browser when media is inserted
1369
1370   //#define MEDIA_MENU_AT_TOP              // Force the media menu to be listed on the top of the main menu
1371
1372   #define EVENT_GCODE_SD_ABORT "G28XY"      // G-code to run on SD Abort Print (e.g., "G28XY" or "G27")
1373
1374   #if ENABLED(PRINTER_EVENT_LEDS)
1375     #define PE_LEDS_COMPLETED_TIME  (30*60) // (seconds) Time to keep the LED "done" color before restoring normal illumination
1376   #endif
1377
1378   /**
1379    * Continue after Power-Loss (Creality3D)
1380    *
1381    * Store the current state to the SD Card at the start of each layer
1382    * during SD printing. If the recovery file is found at boot time, present
1383    * an option on the LCD screen to continue the print from the last-known
1384    * point in the file.
1385    */
1386   //#define POWER_LOSS_RECOVERY
1387   #if ENABLED(POWER_LOSS_RECOVERY)
1388     #define PLR_ENABLED_DEFAULT   false // Power Loss Recovery enabled by default. (Set with 'M413 Sn' & M500)
1389     //#define BACKUP_POWER_SUPPLY       // Backup power / UPS to move the steppers on power loss
1390     //#define POWER_LOSS_ZRAISE       2 // (mm) Z axis raise on resume (on power loss with UPS)
1391     //#define POWER_LOSS_PIN         44 // Pin to detect power loss. Set to -1 to disable default pin on boards without module.
1392     //#define POWER_LOSS_STATE     HIGH // State of pin indicating power loss
1393     //#define POWER_LOSS_PULLUP         // Set pullup / pulldown as appropriate for your sensor
1394     //#define POWER_LOSS_PULLDOWN
1395     //#define POWER_LOSS_PURGE_LEN   20 // (mm) Length of filament to purge on resume
1396     //#define POWER_LOSS_RETRACT_LEN 10 // (mm) Length of filament to retract on fail. Requires backup power.
1397
1398     // Without a POWER_LOSS_PIN the following option helps reduce wear on the SD card,
1399     // especially with "vase mode" printing. Set too high and vases cannot be continued.
1400     #define POWER_LOSS_MIN_Z_CHANGE 0.05 // (mm) Minimum Z change before saving power-loss data
1401
1402     // Enable if Z homing is needed for proper recovery. 99.9% of the time this should be disabled!
1403     //#define POWER_LOSS_RECOVER_ZHOME
1404     #if ENABLED(POWER_LOSS_RECOVER_ZHOME)
1405       //#define POWER_LOSS_ZHOME_POS { 0, 0 } // Safe XY position to home Z while avoiding objects on the bed
```

```
while avoiding objects on the bed
    #endif
  #endif

  /**
   * Sort SD file listings in alphabetical order.
   *
   * With this option enabled, items on SD cards will be sorted
   * by name for easier navigation.
   *
   * By default...
   *
   *  - Use the slowest -but safest- method for sorting.
   *  - Folders are sorted to the top.
   *  - The sort key is statically allocated.
   *  - No added G-code (M34) support.
   *  - 40 item sorting limit. (Items after the first 40 are unsorted.)
   *
   * SD sorting uses static allocation (as set by SDSORT_LIMIT), allowing the
   * compiler to calculate the worst-case usage and throw an error if the SRAM
   * limit is exceeded.
   *
   *  - SDSORT_USES_RAM provides faster sorting via a static directory buffer.
   *  - SDSORT_USES_STACK does the same, but uses a local stack-based buffer.
   *  - SDSORT_CACHE_NAMES will retain the sorted file listing in RAM. (Expensive!)
   *  - SDSORT_DYNAMIC_RAM only uses RAM when the SD menu is visible. (Use with caution!)
   */
  //#define SDCARD_SORT_ALPHA

  // SD Card Sorting options
  #if ENABLED(SDCARD_SORT_ALPHA)
    #define SDSORT_LIMIT       40     // Maximum number of sorted items (10-256). Costs 27 bytes each.
    #define FOLDER_SORTING     -1     // -1=above  0=none  1=below
    #define SDSORT_GCODE       false  // Allow turning sorting on/off with LCD and M34 G-code.
    #define SDSORT_USES_RAM    false  // Pre-allocate a static array for faster pre-sorting.
    #define SDSORT_USES_STACK  false  // Prefer the stack for pre-sorting to give back some SRAM. (Negated by next 2 options.)
    #define SDSORT_CACHE_NAMES false  // Keep sorted items in RAM longer for speedy performance. Most expensive option.
    #define SDSORT_DYNAMIC_RAM false  // Use dynamic allocation (within SD menus). Least expensive option. Set SDSORT_LIMIT before use!
    #define SDSORT_CACHE_VFATS 2      // Maximum number of 13-byte VFAT entries to use for sorting.
                                      // Note: Only affects SCROLL_LONG_FILENAMES with SDSORT_CACHE_NAMES but not SDSORT_DYNAMIC_RAM.
  #endif

  // Allow international symbols in long filenames. To display correctly, the
  // LCD's font must contain the characters. Check your selected LCD
```

```
language.
  //#define UTF_FILENAME_SUPPORT

  // This allows hosts to request long names for files and folders with M33
  //#define LONG_FILENAME_HOST_SUPPORT

  // Enable this option to scroll long filenames in the SD card menu
  //#define SCROLL_LONG_FILENAMES

  // Leave the heaters on after Stop Print (not recommended!)
  //#define SD_ABORT_NO_COOLDOWN

  /**
   * This option allows you to abort SD printing when any endstop is
triggered.
   * This feature must be enabled with "M540 S1" or from the LCD menu.
   * To have any effect, endstops must be enabled during SD printing.
   */
  //#define SD_ABORT_ON_ENDSTOP_HIT

  /**
   * This option makes it easier to print the same SD Card file again.
   * On print completion the LCD Menu will open with the file selected.
   * You can just click to start the print, or navigate elsewhere.
   */
  //#define SD_REPRINT_LAST_SELECTED_FILE

  /**
   * Auto-report SdCard status with M27 S<seconds>
   */
  //#define AUTO_REPORT_SD_STATUS

  /**
   * Support for USB thumb drives using an Arduino USB Host Shield or
   * equivalent MAX3421E breakout board. The USB thumb drive will appear
   * to Marlin as an SD card.
   *
   * The MAX3421E can be assigned the same pins as the SD card reader, with
   * the following pin mapping:
   *
   *    SCLK, MOSI, MISO --> SCLK, MOSI, MISO
   *    INT              --> SD_DETECT_PIN [1]
   *    SS               --> SDSS
   *
   * [1] On AVR an interrupt-capable pin is best for UHS3 compatibility.
   */
  //#define USB_FLASH_DRIVE_SUPPORT
  #if ENABLED(USB_FLASH_DRIVE_SUPPORT)
    /**
     * USB Host Shield Library
     *
     * - UHS2 uses no interrupts and has been production-tested
     *   on a LulzBot TAZ Pro with a 32-bit Archim board.
     *
     * - UHS3 is newer code with better USB compatibility. But it
     *   is less tested and is known to interfere with Servos.
     *   [1] This requires USB_INTR_PIN to be interrupt-capable.
     */
    //#define USE_UHS2_USB
```

```
    //#define USE_UHS2_USB
    //#define USE_UHS3_USB

    /**
     * Native USB Host supported by some boards (USB OTG)
     */
    //#define USE_OTG_USB_HOST

    #if DISABLED(USE_OTG_USB_HOST)
      #define USB_CS_PIN    SDSS
      #define USB_INTR_PIN  SD_DETECT_PIN
    #endif
  #endif

  /**
   * When using a bootloader that supports SD-Firmware-Flashing,
   * add a menu item to activate SD-FW-Update on the next reboot.
   *
   * Requires ATMEGA2560 (Arduino Mega)
   *
   * Tested with this bootloader:
   *   https://github.com/FleetProbe/MicroBridge-Arduino-ATMega2560
   */
  //#define SD_FIRMWARE_UPDATE
  #if ENABLED(SD_FIRMWARE_UPDATE)
    #define SD_FIRMWARE_UPDATE_EEPROM_ADDR    0x1FF
    #define SD_FIRMWARE_UPDATE_ACTIVE_VALUE   0xF0
    #define SD_FIRMWARE_UPDATE_INACTIVE_VALUE 0xFF
  #endif

  // Add an optimized binary file transfer mode, initiated with 'M28 B1'
  //#define BINARY_FILE_TRANSFER

  /**
   * Set this option to one of the following (or the board's defaults apply):
   *
   *           LCD - Use the SD drive in the external LCD controller.
   *       ONBOARD - Use the SD drive on the control board.
   *  CUSTOM_CABLE - Use a custom cable to access the SD (as defined in a pins file).
   *
   * :[ 'LCD', 'ONBOARD', 'CUSTOM_CABLE' ]
   */
  //#define SDCARD_CONNECTION LCD

  // Enable if SD detect is rendered useless (e.g., by using an SD extender)
  //#define NO_SD_DETECT

  // Multiple volume support - EXPERIMENTAL.
  //#define MULTI_VOLUME
  #if ENABLED(MULTI_VOLUME)
    #define VOLUME_SD_ONBOARD
    #define VOLUME_USB_FLASH_DRIVE
    #define DEFAULT_VOLUME SV_SD_ONBOARD
    #define DEFAULT_SHARED_VOLUME SV_USB_FLASH_DRIVE
  #endif

#endif // SDSUPPORT
```

```
1562
1563 /**
1564  * By default an onboard SD card reader may be shared as a USB mass-
1565  * storage device. This option hides the SD card from the host PC.
1566  */
1567 //#define NO_SD_HOST_DRIVE   // Disable SD Card access over USB (for
    security).
1568
1569 /**
1570  * Additional options for Graphical Displays
1571  *
1572  * Use the optimizations here to improve printing performance,
1573  * which can be adversely affected by graphical display drawing,
1574  * especially when doing several short moves, and when printing
1575  * on DELTA and SCARA machines.
1576  *
1577  * Some of these options may result in the display lagging behind
1578  * controller events, as there is a trade-off between reliable
1579  * printing performance versus fast display updates.
1580  */
1581 #if HAS_MARLINUI_U8GLIB
1582   // Save many cycles by drawing a hollow frame or no frame on the Info
    Screen
1583   //#define XYZ_NO_FRAME
1584   #define XYZ_HOLLOW_FRAME
1585
1586   // A bigger font is available for edit items. Costs 3120 bytes of PROGMEM.
1587   // Western only. Not available for Cyrillic, Kana, Turkish, Greek, or
    Chinese.
1588   //#define USE_BIG_EDIT_FONT
1589
1590   // A smaller font may be used on the Info Screen. Costs 2434 bytes of
    PROGMEM.
1591   // Western only. Not available for Cyrillic, Kana, Turkish, Greek, or
    Chinese.
1592   //#define USE_SMALL_INFOFONT
1593
1594   /**
1595    * ST7920-based LCDs can emulate a 16 x 4 character display using
1596    * the ST7920 character-generator for very fast screen updates.
1597    * Enable LIGHTWEIGHT_UI to use this special display mode.
1598    *
1599    * Since LIGHTWEIGHT_UI has limited space, the position and status
1600    * message occupy the same line. Set STATUS_EXPIRE_SECONDS to the
1601    * length of time to display the status message before clearing.
1602    *
1603    * Set STATUS_EXPIRE_SECONDS to zero to never clear the status.
1604    * This will prevent position updates from being displayed.
1605    */
1606   #if ENABLED(U8GLIB_ST7920)
1607     // Enable this option and reduce the value to optimize screen updates.
1608     // The normal delay is 10µs. Use the lowest value that still gives a
    reliable display.
1609     //#define DOGM_SPI_DELAY_US 5
1610
1611     //#define LIGHTWEIGHT_UI
1612     #if ENABLED(LIGHTWEIGHT_UI)
1613       #define STATUS_EXPIRE_SECONDS 20
1614     #endif
```

```
    #endif
  #endif

  /**
   * Status (Info) Screen customizations
   * These options may affect code size and screen render time.
   * Custom status screens can forcibly override these settings.
   */
  //#define STATUS_COMBINE_HEATERS    // Use combined heater images instead of separate ones
  //#define STATUS_HOTEND_NUMBERLESS  // Use plain hotend icons instead of numbered ones (with 2+ hotends)
  #define STATUS_HOTEND_INVERTED      // Show solid nozzle bitmaps when heating (Requires STATUS_HOTEND_ANIM for numbered hotends)
  #define STATUS_HOTEND_ANIM          // Use a second bitmap to indicate hotend heating
  #define STATUS_BED_ANIM             // Use a second bitmap to indicate bed heating
  #define STATUS_CHAMBER_ANIM         // Use a second bitmap to indicate chamber heating
  //#define STATUS_CUTTER_ANIM        // Use a second bitmap to indicate spindle / laser active
  //#define STATUS_COOLER_ANIM        // Use a second bitmap to indicate laser cooling
  //#define STATUS_FLOWMETER_ANIM     // Use multiple bitmaps to indicate coolant flow
  //#define STATUS_ALT_BED_BITMAP     // Use the alternative bed bitmap
  //#define STATUS_ALT_FAN_BITMAP     // Use the alternative fan bitmap
  //#define STATUS_FAN_FRAMES 3       // :[0,1,2,3,4] Number of fan animation frames
  //#define STATUS_HEAT_PERCENT       // Show heating in a progress bar
  //#define BOOT_MARLIN_LOGO_ANIMATED // Animated Marlin logo. Costs ~3260 (or ~940) bytes of PROGMEM.

  // Frivolous Game Options
  //#define MARLIN_BRICKOUT
  //#define MARLIN_INVADERS
  //#define MARLIN_SNAKE
  //#define GAMES_EASTER_EGG          // Add extra blank lines above the "Games" sub-menu

#endif // HAS_MARLINUI_U8GLIB

#if HAS_MARLINUI_U8GLIB || IS_DWIN_MARLINUI
  // Show SD percentage next to the progress bar
  //#define SHOW_SD_PERCENT

  // Enable to save many cycles by drawing a hollow frame on Menu Screens
  #define MENU_HOLLOW_FRAME

  // Swap the CW/CCW indicators in the graphics overlay
  //#define OVERLAY_GFX_REVERSE
#endif

//
// Additional options for DGUS / DWIN displays
//
#if HAS_DGUS_LCD
  #define LCD_SERIAL_PORT 3
```

```
  #define LCD_BAUDRATE 115200

  #define DGUS_RX_BUFFER_SIZE 128
  #define DGUS_TX_BUFFER_SIZE 48
  //#define SERIAL_STATS_RX_BUFFER_OVERRUNS  // Fix Rx overrun situation (Currently only for AVR)

  #define DGUS_UPDATE_INTERVAL_MS  500    // (ms) Interval between automatic screen updates

  #if ANY(DGUS_LCD_UI_FYSETC, DGUS_LCD_UI_MKS, DGUS_LCD_UI_HIPRECY)
    #define DGUS_PRINT_FILENAME           // Display the filename during printing
    #define DGUS_PREHEAT_UI               // Display a preheat screen during heatup

    #if EITHER(DGUS_LCD_UI_FYSETC, DGUS_LCD_UI_MKS)
      //#define DGUS_UI_MOVE_DIS_OPTION   // Disabled by default for FYSETC and MKS
    #else
      #define DGUS_UI_MOVE_DIS_OPTION     // Enabled by default for UI_HIPRECY
    #endif

    #define DGUS_FILAMENT_LOADUNLOAD
    #if ENABLED(DGUS_FILAMENT_LOADUNLOAD)
      #define DGUS_FILAMENT_PURGE_LENGTH 10
      #define DGUS_FILAMENT_LOAD_LENGTH_PER_TIME 0.5 // (mm) Adjust in proportion to DGUS_UPDATE_INTERVAL_MS
    #endif

    #define DGUS_UI_WAITING               // Show a "waiting" screen between some screens
    #if ENABLED(DGUS_UI_WAITING)
      #define DGUS_UI_WAITING_STATUS 10
      #define DGUS_UI_WAITING_STATUS_PERIOD 8 // Increase to slower waiting status looping
    #endif
  #endif
#endif // HAS_DGUS_LCD

//
// Additional options for AnyCubic Chiron TFT displays
//
#if ENABLED(ANYCUBIC_LCD_CHIRON)
  // By default the type of panel is automatically detected.
  // Enable one of these options if you know the panel type.
  //#define CHIRON_TFT_STANDARD
  //#define CHIRON_TFT_NEW

  // Enable the longer Anycubic powerup startup tune
  //#define AC_DEFAULT_STARTUP_TUNE

  /**
   * Display Folders
   * By default the file browser lists all G-code files (including those in subfolders) in a flat list.
   * Enable this option to display a hierarchical file browser.
```

```
   *
   * NOTES:
   * - Without this option it helps to enable SDCARD_SORT_ALPHA so files are sorted before/after folders.
   * - When used with the "new" panel, folder names will also have '.gcode' appended to their names.
   *   This hack is currently required to force the panel to show folders.
   */
  #define AC_SD_FOLDER_VIEW
#endif

//
// Specify additional languages for the UI. Default specified by LCD_LANGUAGE.
//
#if ANY(DOGLCD, TFT_COLOR_UI, TOUCH_UI_FTDI_EVE, IS_DWIN_MARLINUI)
  //#define LCD_LANGUAGE_2 fr
  //#define LCD_LANGUAGE_3 de
  //#define LCD_LANGUAGE_4 es
  //#define LCD_LANGUAGE_5 it
  #ifdef LCD_LANGUAGE_2
    //#define LCD_LANGUAGE_AUTO_SAVE // Automatically save language to EEPROM on change
  #endif
#endif

//
// Touch UI for the FTDI Embedded Video Engine (EVE)
//
#if ENABLED(TOUCH_UI_FTDI_EVE)
  // Display board used
  //#define LCD_FTDI_VM800B35A        // FTDI 3.5" with FT800 (320x240)
  //#define LCD_4DSYSTEMS_4DLCD_FT843 // 4D Systems 4.3" (480x272)
  //#define LCD_HAOYU_FT800CB         // Haoyu with 4.3" or 5" (480x272)
  //#define LCD_HAOYU_FT810CB         // Haoyu with 5" (800x480)
  //#define LCD_LULZBOT_CLCD_UI       // LulzBot Color LCD UI
  //#define LCD_FYSETC_TFT81050       // FYSETC with 5" (800x480)
  //#define LCD_EVE3_50G              // Matrix Orbital 5.0", 800x480, BT815
  //#define LCD_EVE2_50G              // Matrix Orbital 5.0", 800x480, FT813

  // Correct the resolution if not using the stock TFT panel.
  //#define TOUCH_UI_320x240
  //#define TOUCH_UI_480x272
  //#define TOUCH_UI_800x480

  // Mappings for boards with a standard RepRapDiscount Display connector
  //#define AO_EXP1_PINMAP      // LulzBot CLCD UI EXP1 mapping
  //#define AO_EXP2_PINMAP      // LulzBot CLCD UI EXP2 mapping
  //#define CR10_TFT_PINMAP     // Rudolph Riedel's CR10 pin mapping
  //#define S6_TFT_PINMAP       // FYSETC S6 pin mapping
  //#define F6_TFT_PINMAP       // FYSETC F6 pin mapping

  //#define OTHER_PIN_LAYOUT  // Define pins manually below
  #if ENABLED(OTHER_PIN_LAYOUT)
    // Pins for CS and MOD_RESET (PD) must be chosen
    #define CLCD_MOD_RESET  9
    #define CLCD_SPI_CS    10

    // If using software SPI, specify pins for SCLK, MOSI, MISO
```

```
    //#define CLCD_USE_SOFT_SPI
    #if ENABLED(CLCD_USE_SOFT_SPI)
      #define CLCD_SOFT_SPI_MOSI 11
      #define CLCD_SOFT_SPI_MISO 12
      #define CLCD_SOFT_SPI_SCLK 13
    #endif
  #endif

  // Display Orientation. An inverted (i.e. upside-down) display
  // is supported on the FT800. The FT810 and beyond also support
  // portrait and mirrored orientations.
  //#define TOUCH_UI_INVERTED
  //#define TOUCH_UI_PORTRAIT
  //#define TOUCH_UI_MIRRORED

  // UTF8 processing and rendering.
  // Unsupported characters are shown as '?'.
  //#define TOUCH_UI_USE_UTF8
  #if ENABLED(TOUCH_UI_USE_UTF8)
    // Western accents support. These accented characters use
    // combined bitmaps and require relatively little storage.
    #define TOUCH_UI_UTF8_WESTERN_CHARSET
    #if ENABLED(TOUCH_UI_UTF8_WESTERN_CHARSET)
      // Additional character groups. These characters require
      // full bitmaps and take up considerable storage:
      //#define TOUCH_UI_UTF8_SUPERSCRIPTS  // ¹ ² ³
      //#define TOUCH_UI_UTF8_COPYRIGHT     // © ®
      //#define TOUCH_UI_UTF8_GERMANIC      // ß
      //#define TOUCH_UI_UTF8_SCANDINAVIAN  // Æ Ð Ø Þ æ ð ø þ
      //#define TOUCH_UI_UTF8_PUNCTUATION   // « » ¿ ¡
      //#define TOUCH_UI_UTF8_CURRENCY      // ¢ £ ¤ ¥
      //#define TOUCH_UI_UTF8_ORDINALS      // º ª
      //#define TOUCH_UI_UTF8_MATHEMATICS   // ± × ÷
      //#define TOUCH_UI_UTF8_FRACTIONS     // ¼ ½ ¾
      //#define TOUCH_UI_UTF8_SYMBOLS       // µ ¶ ¦ § ¬
    #endif

    // Cyrillic character set, costs about 27KiB of flash
    //#define TOUCH_UI_UTF8_CYRILLIC_CHARSET
  #endif

  // Use a smaller font when labels don't fit buttons
  #define TOUCH_UI_FIT_TEXT

  // Use a numeric passcode for "Screen lock" keypad.
  // (recommended for smaller displays)
  //#define TOUCH_UI_PASSCODE

  // Output extra debug info for Touch UI events
  //#define TOUCH_UI_DEBUG

  // Developer menu (accessed by touching "About Printer" copyright text)
  //#define TOUCH_UI_DEVELOPER_MENU
#endif

//
// Classic UI Options
//
```

```
#if TFT_SCALED_DOGLCD
  //#define TFT_MARLINUI_COLOR 0xFFFF // White
  //#define TFT_MARLINBG_COLOR 0x0000 // Black
  //#define TFT_DISABLED_COLOR 0x0003 // Almost black
  //#define TFT_BTCANCEL_COLOR 0xF800 // Red
  //#define TFT_BTARROWS_COLOR 0xDEE6 // 11011 110111 00110 Yellow
  //#define TFT_BTOKMENU_COLOR 0x145F // 00010 100010 11111 Cyan
#endif

//
// ADC Button Debounce
//
#if HAS_ADC_BUTTONS
  #define ADC_BUTTON_DEBOUNCE_DELAY 16  // Increase if buttons bounce or repeat too fast
#endif

// @section safety

/**
 * The watchdog hardware timer will do a reset and disable all outputs
 * if the firmware gets too overloaded to read the temperature sensors.
 *
 * If you find that watchdog reboot causes your AVR board to hang forever,
 * enable WATCHDOG_RESET_MANUAL to use a custom timer instead of WDTO.
 * NOTE: This method is less reliable as it can only catch hangups while
 * interrupts are enabled.
 */
#define USE_WATCHDOG
#if ENABLED(USE_WATCHDOG)
  //#define WATCHDOG_RESET_MANUAL
#endif

// @section lcd

/**
 * Babystepping enables movement of the axes by tiny increments without changing
 * the current position values. This feature is used primarily to adjust the Z
 * axis in the first layer of a print in real-time.
 *
 * Warning: Does not respect endstops!
 */
//#define BABYSTEPPING
#if ENABLED(BABYSTEPPING)
  //#define INTEGRATED_BABYSTEPPING         // EXPERIMENTAL integration of babystepping into the Stepper ISR
  //#define BABYSTEP_WITHOUT_HOMING
  //#define BABYSTEP_ALWAYS_AVAILABLE       // Allow babystepping at all times (not just during movement).
  //#define BABYSTEP_XY                     // Also enable X/Y Babystepping. Not supported on DELTA!
  #define BABYSTEP_INVERT_Z false           // Change if Z babysteps should go the other way
  //#define BABYSTEP_MILLIMETER_UNITS       // Specify BABYSTEP_MULTIPLICATOR_(XY|Z) in mm instead of micro-steps
  #define BABYSTEP_MULTIPLICATOR_Z  1       // (steps or mm) Steps or millimeter distance for each Z babystep
```

```
  #define BABYSTEP_MULTIPLICATOR_XY 1       // (steps or mm) Steps or millimeter distance for each XY babystep

  //#define DOUBLECLICK_FOR_Z_BABYSTEPPING  // Double-click on the Status Screen for Z Babystepping.
  #if ENABLED(DOUBLECLICK_FOR_Z_BABYSTEPPING)
    #define DOUBLECLICK_MAX_INTERVAL 1250   // Maximum interval between clicks, in milliseconds.
                                            // Note: Extra time may be added to mitigate controller latency.
    //#define MOVE_Z_WHEN_IDLE              // Jump to the move Z menu on doubleclick when printer is idle.
    #if ENABLED(MOVE_Z_WHEN_IDLE)
      #define MOVE_Z_IDLE_MULTIPLICATOR 1   // Multiply 1mm by this factor for the move step size.
    #endif
  #endif

  //#define BABYSTEP_DISPLAY_TOTAL          // Display total babysteps since last G28

  //#define BABYSTEP_ZPROBE_OFFSET          // Combine M851 Z and Babystepping
  #if ENABLED(BABYSTEP_ZPROBE_OFFSET)
    //#define BABYSTEP_HOTEND_Z_OFFSET      // For multiple hotends, babystep relative Z offsets
    //#define BABYSTEP_ZPROBE_GFX_OVERLAY   // Enable graphical overlay on Z-offset editor
  #endif
#endif

// @section extruder

/**
 * Linear Pressure Control v1.5
 *
 * Assumption: advance [steps] = k * (delta velocity [steps/s])
 * K=0 means advance disabled.
 *
 * NOTE: K values for LIN_ADVANCE 1.5 differ from earlier versions!
 *
 * Set K around 0.22 for 3mm PLA Direct Drive with ~6.5cm between the drive gear and heatbreak.
 * Larger K values will be needed for flexible filament and greater distances.
 * If this algorithm produces a higher speed offset than the extruder can handle (compared to E jerk)
 * print acceleration will be reduced during the affected moves to keep within the limit.
 *
 * See https://marlinfw.org/docs/features/lin_advance.html for full instructions.
 */
//#define LIN_ADVANCE
#if ENABLED(LIN_ADVANCE)
  //#define EXTRA_LIN_ADVANCE_K // Enable for second linear advance constants
  #define LIN_ADVANCE_K 0.22    // Unit: mm compression per 1mm/s extruder
```

```
speed
  //#define LA_DEBUG           // If enabled, this will generate debug information output over USB.
  //#define EXPERIMENTAL_SCURVE // Enable this option to permit S-Curve Acceleration
#endif

// @section leveling

/**
 * Points to probe for all 3-point Leveling procedures.
 * Override if the automatically selected points are inadequate.
 */
#if EITHER(AUTO_BED_LEVELING_3POINT, AUTO_BED_LEVELING_UBL)
  //#define PROBE_PT_1_X 15
  //#define PROBE_PT_1_Y 180
  //#define PROBE_PT_2_X 15
  //#define PROBE_PT_2_Y 20
  //#define PROBE_PT_3_X 170
  //#define PROBE_PT_3_Y 20
#endif

/**
 * Probing Margins
 *
 * Override PROBING_MARGIN for each side of the build plate
 * Useful to get probe points to exact positions on targets or
 * to allow leveling to avoid plate clamps on only specific
 * sides of the bed. With NOZZLE_AS_PROBE negative values are
 * allowed, to permit probing outside the bed.
 *
 * If you are replacing the prior *_PROBE_BED_POSITION options,
 * LEFT and FRONT values in most cases will map directly over
 * RIGHT and REAR would be the inverse such as
 * (X/Y_BED_SIZE - RIGHT/BACK_PROBE_BED_POSITION)
 *
 * This will allow all positions to match at compilation, however
 * should the probe position be modified with M851XY then the
 * probe points will follow. This prevents any change from causing
 * the probe to be unable to reach any points.
 */
#if PROBE_SELECTED && !IS_KINEMATIC
  //#define PROBING_MARGIN_LEFT PROBING_MARGIN
  //#define PROBING_MARGIN_RIGHT PROBING_MARGIN
  //#define PROBING_MARGIN_FRONT PROBING_MARGIN
  //#define PROBING_MARGIN_BACK PROBING_MARGIN
#endif

#if EITHER(MESH_BED_LEVELING, AUTO_BED_LEVELING_UBL)
  // Override the mesh area if the automatic (max) area is too large
  //#define MESH_MIN_X MESH_INSET
  //#define MESH_MIN_Y MESH_INSET
  //#define MESH_MAX_X X_BED_SIZE - (MESH_INSET)
  //#define MESH_MAX_Y Y_BED_SIZE - (MESH_INSET)
#endif

#if BOTH(AUTO_BED_LEVELING_UBL, EEPROM_SETTINGS)
  //#define OPTIMIZED_MESH_STORAGE  // Store mesh with less precision to save EEPROM space
```

```
#endif

/**
 * Repeatedly attempt G29 leveling until it succeeds.
 * Stop after G29_MAX_RETRIES attempts.
 */
//#define G29_RETRY_AND_RECOVER
#if ENABLED(G29_RETRY_AND_RECOVER)
  #define G29_MAX_RETRIES 3
  #define G29_HALT_ON_FAILURE
  /**
   * Specify the GCODE commands that will be executed when leveling succeeds,
   * between attempts, and after the maximum number of retries have been tried.
   */
  #define G29_SUCCESS_COMMANDS "M117 Bed leveling done."
  #define G29_RECOVER_COMMANDS "M117 Probe failed. Rewiping.\nG28\nG12 P0 S12 T0"
  #define G29_FAILURE_COMMANDS "M117 Bed leveling failed.\nG0 Z10\nM300 P25 S880\nM300 P50 S0\nM300 P25 S880\nM300 P50 S0\nM300 P25 S880\nM300 P50 S0\nG4 S1"

#endif

/**
 * Thermal Probe Compensation
 * Probe measurements are adjusted to compensate for temperature distortion.
 * Use G76 to calibrate this feature. Use M871 to set values manually.
 * For a more detailed explanation of the process see G76_M871.cpp.
 */
#if HAS_BED_PROBE && TEMP_SENSOR_PROBE && TEMP_SENSOR_BED
  // Enable thermal first layer compensation using bed and probe temperatures
  #define PROBE_TEMP_COMPENSATION

  // Add additional compensation depending on hotend temperature
  // Note: this values cannot be calibrated and have to be set manually
  #if ENABLED(PROBE_TEMP_COMPENSATION)
    // Park position to wait for probe cooldown
    #define PTC_PARK_POS   { 0, 0, 100 }

    // Probe position to probe and wait for probe to reach target temperature
    #define PTC_PROBE_POS  { 90, 100 }

    // Enable additional compensation using hotend temperature
    // Note: this values cannot be calibrated automatically but have to be set manually
    //#define USE_TEMP_EXT_COMPENSATION

    // Probe temperature calibration generates a table of values starting at PTC_SAMPLE_START
    // (e.g., 30), in steps of PTC_SAMPLE_RES (e.g., 5) with PTC_SAMPLE_COUNT (e.g., 10) samples.

    //#define PTC_SAMPLE_START  30  // (°C)
    //#define PTC_SAMPLE_RES     5  // (°C)
```

```
    //#define PTC_SAMPLE_COUNT  10

    // Bed temperature calibration builds a similar table.

    //#define BTC_SAMPLE_START  60  // (°C)
    //#define BTC_SAMPLE_RES     5  // (°C)
    //#define BTC_SAMPLE_COUNT  10

    // The temperature the probe should be at while taking measurements during bed temperature
    // calibration.
    //#define BTC_PROBE_TEMP    30  // (°C)

    // Height above Z=0.0 to raise the nozzle. Lowering this can help the probe to heat faster.
    // Note: the Z=0.0 offset is determined by the probe offset which can be set using M851.
    //#define PTC_PROBE_HEATING_OFFSET 0.5

    // Height to raise the Z-probe between heating and taking the next measurement. Some probes
    // may fail to untrigger if they have been triggered for a long time, which can be solved by
    // increasing the height the probe is raised to.
    //#define PTC_PROBE_RAISE 15

    // If the probe is outside of the defined range, use linear extrapolation using the closest
    // point and the PTC_LINEAR_EXTRAPOLATION'th next point. E.g. if set to 4 it will use data[0]
    // and data[4] to perform linear extrapolation for values below PTC_SAMPLE_START.
    //#define PTC_LINEAR_EXTRAPOLATION 4
  #endif
#endif

// @section extras

//
// G60/G61 Position Save and Return
//
//#define SAVED_POSITIONS 1         // Each saved position slot costs 12 bytes

//
// G2/G3 Arc Support
//
#define ARC_SUPPORT                   // Requires ~3226 bytes
#if ENABLED(ARC_SUPPORT)
  #define MIN_ARC_SEGMENT_MM      0.1 // (mm) Minimum length of each arc segment
  #define MAX_ARC_SEGMENT_MM      1.0 // (mm) Maximum length of each arc segment
  #define MIN_CIRCLE_SEGMENTS    72   // Minimum number of segments in a complete circle
  //#define ARC_SEGMENTS_PER_SEC 50   // Use the feedrate to choose the segment length
  #define N_ARC_CORRECTION       25   // Number of interpolated segments between corrections
```

```
between corrections
  //#define ARC_P_CIRCLES             // Enable the 'P' parameter to specify complete circles
  //#define SF_ARC_FIX                // Enable only if using SkeinForge with "Arc Point" fillet procedure
#endif

// G5 Bézier Curve Support with XYZE destination and IJPQ offsets
//#define BEZIER_CURVE_SUPPORT        // Requires ~2666 bytes

#if EITHER(ARC_SUPPORT, BEZIER_CURVE_SUPPORT)
  //#define CNC_WORKSPACE_PLANES      // Allow G2/G3/G5 to operate in XY, ZX, or YZ planes
#endif

/**
 * Direct Stepping
 *
 * Comparable to the method used by Klipper, G6 direct stepping significantly
 * reduces motion calculations, increases top printing speeds, and results in
 * less step aliasing by calculating all motions in advance.
 * Preparing your G-code: https://github.com/colinrgodsey/step-daemon
 */
//#define DIRECT_STEPPING

/**
 * G38 Probe Target
 *
 * This option adds G38.2 and G38.3 (probe towards target)
 * and optionally G38.4 and G38.5 (probe away from target).
 * Set MULTIPLE_PROBING for G38 to probe more than once.
 */
//#define G38_PROBE_TARGET
#if ENABLED(G38_PROBE_TARGET)
  //#define G38_PROBE_AWAY        // Include G38.4 and G38.5 to probe away from target
  #define G38_MINIMUM_MOVE 0.0275 // (mm) Minimum distance that will produce a move.
#endif

// Moves (or segments) with fewer steps than this will be joined with the next move
#define MIN_STEPS_PER_SEGMENT 6

/**
 * Minimum delay before and after setting the stepper DIR (in ns)
 *     0 : No delay (Expect at least 10µS since one Stepper ISR must transpire)
 *    20 : Minimum for TMC2xxx drivers
 *   200 : Minimum for A4988 drivers
 *   400 : Minimum for A5984 drivers
 *   500 : Minimum for LV8729 drivers (guess, no info in datasheet)
 *   650 : Minimum for DRV8825 drivers
 *  1500 : Minimum for TB6600 drivers (guess, no info in datasheet)
 * 15000 : Minimum for TB6560 drivers (guess, no info in datasheet)
 *
 * Override the default value based on the driver type set in
```

```
Configuration.h.
 */
//#define MINIMUM_STEPPER_POST_DIR_DELAY 650
//#define MINIMUM_STEPPER_PRE_DIR_DELAY 650

/**
 * Minimum stepper driver pulse width (in µs)
 *   0 : Smallest possible width the MCU can produce, compatible with
TMC2xxx drivers
 *   0 : Minimum 500ns for LV8729, adjusted in stepper.h
 *   1 : Minimum for A4988 and A5984 stepper drivers
 *   2 : Minimum for DRV8825 stepper drivers
 *   3 : Minimum for TB6600 stepper drivers
 *  30 : Minimum for TB6560 stepper drivers
 *
 * Override the default value based on the driver type set in
Configuration.h.
 */
//#define MINIMUM_STEPPER_PULSE 2

/**
 * Maximum stepping rate (in Hz) the stepper driver allows
 *  If undefined, defaults to 1MHz / (2 * MINIMUM_STEPPER_PULSE)
 *  5000000 : Maximum for TMC2xxx stepper drivers
 *  1000000 : Maximum for LV8729 stepper driver
 *  500000  : Maximum for A4988 stepper driver
 *  250000  : Maximum for DRV8825 stepper driver
 *  150000  : Maximum for TB6600 stepper driver
 *   15000  : Maximum for TB6560 stepper driver
 *
 * Override the default value based on the driver type set in
Configuration.h.
 */
//#define MAXIMUM_STEPPER_RATE 250000

// @section temperature

// Control heater 0 and heater 1 in parallel.
//#define HEATERS_PARALLEL

//===========================================================================
=
//============================= Buffers
=============================
//===========================================================================
=

// @section motion

// The number of linear moves that can be in the planner at once.
// The value of BLOCK_BUFFER_SIZE must be a power of 2 (e.g., 8, 16, 32)
#if BOTH(SDSUPPORT, DIRECT_STEPPING)
  #define BLOCK_BUFFER_SIZE  8
#elif ENABLED(SDSUPPORT)
  #define BLOCK_BUFFER_SIZE 16
#else
  #define BLOCK_BUFFER_SIZE 16
#endif
```

```
// @section serial

// The ASCII buffer for serial input
#define MAX_CMD_SIZE 96
#define BUFSIZE 4

// Transmission to Host Buffer Size
// To save 386 bytes of PROGMEM (and TX_BUFFER_SIZE+3 bytes of RAM) set to 0.
// To buffer a simple "ok" you need 4 bytes.
// For ADVANCED_OK (M105) you need 32 bytes.
// For debug-echo: 128 bytes for the optimal speed.
// Other output doesn't need to be that speedy.
// :[0, 2, 4, 8, 16, 32, 64, 128, 256]
#define TX_BUFFER_SIZE 0

// Host Receive Buffer Size
// Without XON/XOFF flow control (see SERIAL_XON_XOFF below) 32 bytes should be enough.
// To use flow control, set this buffer size to at least 1024 bytes.
// :[0, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048]
//#define RX_BUFFER_SIZE 1024

#if RX_BUFFER_SIZE >= 1024
  // Enable to have the controller send XON/XOFF control characters to
  // the host to signal the RX buffer is becoming full.
  //#define SERIAL_XON_XOFF
#endif

#if ENABLED(SDSUPPORT)
  // Enable this option to collect and display the maximum
  // RX queue usage after transferring a file to SD.
  //#define SERIAL_STATS_MAX_RX_QUEUED

  // Enable this option to collect and display the number
  // of dropped bytes after a file transfer to SD.
  //#define SERIAL_STATS_DROPPED_RX
#endif

// Monitor RX buffer usage
// Dump an error to the serial port if the serial receive buffer overflows.
// If you see these errors, increase the RX_BUFFER_SIZE value.
// Not supported on all platforms.
//#define RX_BUFFER_MONITOR

/**
 * Emergency Command Parser
 *
 * Add a low-level parser to intercept certain commands as they
 * enter the serial receive buffer, so they cannot be blocked.
 * Currently handles M108, M112, M410, M876
 * NOTE: Not yet implemented for all platforms.
 */
//#define EMERGENCY_PARSER

/**
 * Realtime Reporting (requires EMERGENCY_PARSER)
 *
```

```
 * - Report position and state of the machine (like Grbl).
 * - Auto-report position during long moves.
 * - Useful for CNC/LASER.
 *
 * Adds support for commands:
 *  S000 : Report State and Position while moving.
 *  P000 : Instant Pause / Hold while moving.
 *  R000 : Resume from Pause / Hold.
 *
 * - During Hold all Emergency Parser commands are available, as usual.
 * - Enable NANODLP_Z_SYNC and NANODLP_ALL_AXIS for move command end-state reports.
 */
//#define REALTIME_REPORTING_COMMANDS
#if ENABLED(REALTIME_REPORTING_COMMANDS)
  //#define FULL_REPORT_TO_HOST_FEATURE   // Auto-report the machine status like Grbl CNC
#endif

// Bad Serial-connections can miss a received command by sending an 'ok'
// Therefore some clients abort after 30 seconds in a timeout.
// Some other clients start sending commands while receiving a 'wait'.
// This "wait" is only sent when the buffer is empty. 1 second is a good value here.
//#define NO_TIMEOUTS 1000 // Milliseconds

// Some clients will have this feature soon. This could make the NO_TIMEOUTS unnecessary.
//#define ADVANCED_OK

// Printrun may have trouble receiving long strings all at once.
// This option inserts short delays between lines of serial output.
#define SERIAL_OVERRUN_PROTECTION

// For serial echo, the number of digits after the decimal point
//#define SERIAL_FLOAT_PRECISION 4

// @section extras

/**
 * Extra Fan Speed
 * Adds a secondary fan speed for each print-cooling fan.
 *   'M106 P<fan> T3-255' : Set a secondary speed for <fan>
 *   'M106 P<fan> T2'     : Use the set secondary speed
 *   'M106 P<fan> T1'     : Restore the previous fan speed
 */
//#define EXTRA_FAN_SPEED

/**
 * Firmware-based and LCD-controlled retract
 *
 * Add G10 / G11 commands for automatic firmware-based retract / recover.
 * Use M207 and M208 to define parameters for retract / recover.
 *
 * Use M209 to enable or disable auto-retract.
 * With auto-retract enabled, all G1 E moves within the set range
 * will be converted to firmware-based retract/recover moves.
 *
 * Be sure to turn off auto-retract during filament change
```

```
 * Be sure to turn off auto retract during filament change.
 *
 * Note that M207 / M208 / M209 settings are saved to EEPROM.
 */
//#define FWRETRACT
#if ENABLED(FWRETRACT)
  #define FWRETRACT_AUTORETRACT             // Override slicer retractions
  #if ENABLED(FWRETRACT_AUTORETRACT)
    #define MIN_AUTORETRACT              0.1 // (mm) Don't convert E moves under this length
    #define MAX_AUTORETRACT             10.0 // (mm) Don't convert E moves over this length
  #endif
  #define RETRACT_LENGTH                 3   // (mm) Default retract length (positive value)
  #define RETRACT_LENGTH_SWAP           13   // (mm) Default swap retract length (positive value)
  #define RETRACT_FEEDRATE              45   // (mm/s) Default feedrate for retracting
  #define RETRACT_ZRAISE                 0   // (mm) Default retract Z-raise
  #define RETRACT_RECOVER_LENGTH         0   // (mm) Default additional recover length (added to retract length on recover)
  #define RETRACT_RECOVER_LENGTH_SWAP    0   // (mm) Default additional swap recover length (added to retract length on recover from toolchange)
  #define RETRACT_RECOVER_FEEDRATE       8   // (mm/s) Default feedrate for recovering from retraction
  #define RETRACT_RECOVER_FEEDRATE_SWAP  8   // (mm/s) Default feedrate for recovering from swap retraction
  #if ENABLED(MIXING_EXTRUDER)
    //#define RETRACT_SYNC_MIXING           // Retract and restore all mixing steppers simultaneously
  #endif
#endif

/**
 * Universal tool change settings.
 * Applies to all types of extruders except where explicitly noted.
 */
#if HAS_MULTI_EXTRUDER
  // Z raise distance for tool-change, as needed for some extruders
  #define TOOLCHANGE_ZRAISE                 2 // (mm)
  //#define TOOLCHANGE_ZRAISE_BEFORE_RETRACT  // Apply raise before swap retraction (if enabled)
  //#define TOOLCHANGE_NO_RETURN              // Never return to previous position on tool-change
  #if ENABLED(TOOLCHANGE_NO_RETURN)
    //#define EVENT_GCODE_AFTER_TOOLCHANGE "G12X"   // Extra G-code to run after tool-change
  #endif

  /**
   * Extra G-code to run while executing tool-change commands. Can be used to use an additional
   * stepper motor (I axis, see option LINEAR_AXES in Configuration.h) to drive the tool-changer.
   */
  //#define EVENT_GCODE_TOOLCHANGE_T0 "G28 A\nG1 A0" // Extra G-code to run while executing tool-change command T0
  //#define EVENT_GCODE_TOOLCHANGE_T1 "G1 A10"       // Extra G-code to run
```

```
while executing tool-change command T1

  /**
   * Tool Sensors detect when tools have been picked up or dropped.
   * Requires the pins TOOL_SENSOR1_PIN, TOOL_SENSOR2_PIN, etc.
   */
  //#define TOOL_SENSOR

  /**
   * Retract and prime filament on tool-change to reduce
   * ooze and stringing and to get cleaner transitions.
   */
  //#define TOOLCHANGE_FILAMENT_SWAP
  #if ENABLED(TOOLCHANGE_FILAMENT_SWAP)
    // Load / Unload
    #define TOOLCHANGE_FS_LENGTH               12  // (mm) Load / Unload length
    #define TOOLCHANGE_FS_EXTRA_RESUME_LENGTH  0  // (mm) Extra length for better restart, fine tune by LCD/Gcode)
    #define TOOLCHANGE_FS_RETRACT_SPEED   (50*60) // (mm/min) (Unloading)
    #define TOOLCHANGE_FS_UNRETRACT_SPEED (25*60) // (mm/min) (On SINGLENOZZLE or Bowden loading must be slowed down)

    // Longer prime to clean out a SINGLENOZZLE
    #define TOOLCHANGE_FS_EXTRA_PRIME          0  // (mm) Extra priming length
    #define TOOLCHANGE_FS_PRIME_SPEED    (4.6*60) // (mm/min) Extra priming feedrate
    #define TOOLCHANGE_FS_WIPE_RETRACT         0  // (mm/min) Retract before cooling for less stringing, better wipe, etc.

    // Cool after prime to reduce stringing
    #define TOOLCHANGE_FS_FAN                 -1  // Fan index or -1 to skip
    #define TOOLCHANGE_FS_FAN_SPEED          255  // 0-255
    #define TOOLCHANGE_FS_FAN_TIME            10  // (seconds)

    // Swap uninitialized extruder with TOOLCHANGE_FS_PRIME_SPEED for all lengths (recover + prime)
    // (May break filament if not retracted beforehand.)
    //#define TOOLCHANGE_FS_INIT_BEFORE_SWAP

    // Prime on the first T0 (If other, TOOLCHANGE_FS_INIT_BEFORE_SWAP applied)
    // Enable it (M217 V[0/1]) before printing, to avoid unwanted priming on host connect
    //#define TOOLCHANGE_FS_PRIME_FIRST_USED

    /**
     * Tool Change Migration
     * This feature provides G-code and LCD options to switch tools mid-print.
     * All applicable tool properties are migrated so the print can continue.
     * Tools must be closely matching and other restrictions may apply.
     * Useful to:
     *   - Change filament color without interruption
     *   - Switch spools automatically on filament runout
     *   - Switch to a different nozzle on an extruder jam
     */
```

```
     */
    #define TOOLCHANGE_MIGRATION_FEATURE

  #endif

  /**
   * Position to park head during tool change.
   * Doesn't apply to SWITCHING_TOOLHEAD, DUAL_X_CARRIAGE, or PARKING_EXTRUDER
   */
  //#define TOOLCHANGE_PARK
  #if ENABLED(TOOLCHANGE_PARK)
    #define TOOLCHANGE_PARK_XY    { X_MIN_POS + 10, Y_MIN_POS + 10 }
    #define TOOLCHANGE_PARK_XY_FEEDRATE 6000  // (mm/min)
    //#define TOOLCHANGE_PARK_X_ONLY          // X axis only move
    //#define TOOLCHANGE_PARK_Y_ONLY          // Y axis only move
  #endif
#endif // HAS_MULTI_EXTRUDER

/**
 * Advanced Pause for Filament Change
 *  - Adds the G-code M600 Filament Change to initiate a filament change.
 *  - This feature is required for the default FILAMENT_RUNOUT_SCRIPT.
 *
 * Requirements:
 *  - For Filament Change parking enable and configure NOZZLE_PARK_FEATURE.
 *  - For user interaction enable an LCD display, HOST_PROMPT_SUPPORT, or EMERGENCY_PARSER.
 *
 * Enable PARK_HEAD_ON_PAUSE to add the G-code M125 Pause and Park.
 */
//#define ADVANCED_PAUSE_FEATURE
#if ENABLED(ADVANCED_PAUSE_FEATURE)
  #define PAUSE_PARK_RETRACT_FEEDRATE         60  // (mm/s) Initial retract feedrate.
  #define PAUSE_PARK_RETRACT_LENGTH            2  // (mm) Initial retract.
                                                  // This short retract is done immediately, before parking the nozzle.
  #define FILAMENT_CHANGE_UNLOAD_FEEDRATE     10  // (mm/s) Unload filament feedrate. This can be pretty fast.
  #define FILAMENT_CHANGE_UNLOAD_ACCEL        25  // (mm/s^2) Lower acceleration may allow a faster feedrate.
  #define FILAMENT_CHANGE_UNLOAD_LENGTH      100  // (mm) The length of filament for a complete unload.
                                                  //   For Bowden, the full length of the tube and nozzle.
                                                  //   For direct drive, the full length of the nozzle.
                                                  //   Set to 0 for manual unloading.
  #define FILAMENT_CHANGE_SLOW_LOAD_FEEDRATE   6  // (mm/s) Slow move when starting load.
  #define FILAMENT_CHANGE_SLOW_LOAD_LENGTH     0  // (mm) Slow length, to allow time to insert material.
                                                  // 0 to disable start loading and skip to fast load only
  #define FILAMENT_CHANGE_FAST_LOAD_FEEDRATE   6  // (mm/s) Load filament feedrate. This can be pretty fast.
  #define FILAMENT_CHANGE_FAST_LOAD_ACCEL     25  // (mm/s^2) Lower
```

```
acceleration may allow a faster feedrate.
  #define FILAMENT_CHANGE_FAST_LOAD_LENGTH     0  // (mm) Load length of filament, from extruder gear to nozzle.
                                                  //   For Bowden, the full length of the tube and nozzle.
                                                  //   For direct drive, the full length of the nozzle.
  //#define ADVANCED_PAUSE_CONTINUOUS_PURGE       // Purge continuously up to the purge length until interrupted.
  #define ADVANCED_PAUSE_PURGE_FEEDRATE        3  // (mm/s) Extrude feedrate (after loading). Should be slower than load feedrate.
  #define ADVANCED_PAUSE_PURGE_LENGTH         50  // (mm) Length to extrude after loading.
                                                  //   Set to 0 for manual extrusion.
                                                  //   Filament can be extruded repeatedly from the Filament Change menu
                                                  //   until extrusion is consistent, and to purge old filament.
  #define ADVANCED_PAUSE_RESUME_PRIME          0  // (mm) Extra distance to prime nozzle after returning from park.
  //#define ADVANCED_PAUSE_FANS_PAUSE             // Turn off print-cooling fans while the machine is paused.

                                                  // Filament Unload does a Retract, Delay, and Purge first:
  #define FILAMENT_UNLOAD_PURGE_RETRACT       13  // (mm) Unload initial retract length.
  #define FILAMENT_UNLOAD_PURGE_DELAY       5000  // (ms) Delay for the filament to cool after retract.
  #define FILAMENT_UNLOAD_PURGE_LENGTH         8  // (mm) An unretract is done, then this length is purged.
  #define FILAMENT_UNLOAD_PURGE_FEEDRATE      25  // (mm/s) feedrate to purge before unload

  #define PAUSE_PARK_NOZZLE_TIMEOUT           45  // (seconds) Time limit before the nozzle is turned off for safety.
  #define FILAMENT_CHANGE_ALERT_BEEPS         10  // Number of alert beeps to play when a response is needed.
  #define PAUSE_PARK_NO_STEPPER_TIMEOUT           // Enable for XYZ steppers to stay powered on during filament change.
  //#define FILAMENT_CHANGE_RESUME_ON_INSERT      // Automatically continue / load filament when runout sensor is triggered again.
  //#define PAUSE_REHEAT_FAST_RESUME              // Reduce number of waits by not prompting again post-timeout before continuing.

  //#define PARK_HEAD_ON_PAUSE                    // Park the nozzle during pause and filament change.
  //#define HOME_BEFORE_FILAMENT_CHANGE           // If needed, home before parking for filament change

  //#define FILAMENT_LOAD_UNLOAD_GCODES           // Add M701/M702 Load/Unload G-codes, plus Load/Unload in the LCD Prepare menu.
  //#define FILAMENT_UNLOAD_ALL_EXTRUDERS         // Allow M702 to unload all extruders above a minimum target temp (as set by M302)
#endif

// @section tmc
```

```
/**
 * TMC26X Stepper Driver options
 *
 * The TMC26XStepper library is required for this stepper driver.
 * https://github.com/trinamic/TMC26XStepper
 */
#if HAS_DRIVER(TMC26X)

  #if AXIS_DRIVER_TYPE_X(TMC26X)
    #define X_MAX_CURRENT     1000  // (mA)
    #define X_SENSE_RESISTOR    91  // (mOhms)
    #define X_MICROSTEPS        16  // Number of microsteps
  #endif

  #if AXIS_DRIVER_TYPE_X2(TMC26X)
    #define X2_MAX_CURRENT    1000
    #define X2_SENSE_RESISTOR   91
    #define X2_MICROSTEPS       X_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_Y(TMC26X)
    #define Y_MAX_CURRENT     1000
    #define Y_SENSE_RESISTOR    91
    #define Y_MICROSTEPS        16
  #endif

  #if AXIS_DRIVER_TYPE_Y2(TMC26X)
    #define Y2_MAX_CURRENT    1000
    #define Y2_SENSE_RESISTOR   91
    #define Y2_MICROSTEPS       Y_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_Z(TMC26X)
    #define Z_MAX_CURRENT     1000
    #define Z_SENSE_RESISTOR    91
    #define Z_MICROSTEPS        16
  #endif

  #if AXIS_DRIVER_TYPE_Z2(TMC26X)
    #define Z2_MAX_CURRENT    1000
    #define Z2_SENSE_RESISTOR   91
    #define Z2_MICROSTEPS       Z_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_Z3(TMC26X)
    #define Z3_MAX_CURRENT    1000
    #define Z3_SENSE_RESISTOR   91
    #define Z3_MICROSTEPS       Z_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_Z4(TMC26X)
    #define Z4_MAX_CURRENT    1000
    #define Z4_SENSE_RESISTOR   91
    #define Z4_MICROSTEPS       Z_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_I(TMC26X)
    #define I_MAX_CURRENT    1000
```

```
    #define I_SENSE_RESISTOR   91
    #define I_MICROSTEPS       16
  #endif

  #if AXIS_DRIVER_TYPE_J(TMC26X)
    #define J_MAX_CURRENT    1000
    #define J_SENSE_RESISTOR   91
    #define J_MICROSTEPS       16
  #endif

  #if AXIS_DRIVER_TYPE_K(TMC26X)
    #define K_MAX_CURRENT    1000
    #define K_SENSE_RESISTOR   91
    #define K_MICROSTEPS       16
  #endif

  #if AXIS_DRIVER_TYPE_E0(TMC26X)
    #define E0_MAX_CURRENT    1000
    #define E0_SENSE_RESISTOR   91
    #define E0_MICROSTEPS       16
  #endif

  #if AXIS_DRIVER_TYPE_E1(TMC26X)
    #define E1_MAX_CURRENT    1000
    #define E1_SENSE_RESISTOR   91
    #define E1_MICROSTEPS       E0_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_E2(TMC26X)
    #define E2_MAX_CURRENT    1000
    #define E2_SENSE_RESISTOR   91
    #define E2_MICROSTEPS       E0_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_E3(TMC26X)
    #define E3_MAX_CURRENT    1000
    #define E3_SENSE_RESISTOR   91
    #define E3_MICROSTEPS       E0_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_E4(TMC26X)
    #define E4_MAX_CURRENT    1000
    #define E4_SENSE_RESISTOR   91
    #define E4_MICROSTEPS       E0_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_E5(TMC26X)
    #define E5_MAX_CURRENT    1000
    #define E5_SENSE_RESISTOR   91
    #define E5_MICROSTEPS       E0_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_E6(TMC26X)
    #define E6_MAX_CURRENT    1000
    #define E6_SENSE_RESISTOR   91
    #define E6_MICROSTEPS       E0_MICROSTEPS
  #endif

  #if AXIS_DRIVER_TYPE_E7(TMC26X)
```

```
  #if AXIS_DRIVER_TYPE_E7(TMC26X)
    #define E7_MAX_CURRENT    1000
    #define E7_SENSE_RESISTOR   91
    #define E7_MICROSTEPS       E0_MICROSTEPS
  #endif

#endif // TMC26X

// @section tmc_smart

/**
 * To use TMC2130, TMC2160, TMC2660, TMC5130, TMC5160 stepper drivers in SPI mode
 * connect your SPI pins to the hardware SPI interface on your board and define
 * the required CS pins in your `pins_MYBOARD.h` file. (e.g., RAMPS 1.4 uses AUX3
 * pins `X_CS_PIN 53`, `Y_CS_PIN 49`, etc.).
 * You may also use software SPI if you wish to use general purpose IO pins.
 *
 * To use TMC2208 stepper UART-configurable stepper drivers connect #_SERIAL_TX_PIN
 * to the driver side PDN_UART pin with a 1K resistor.
 * To use the reading capabilities, also connect #_SERIAL_RX_PIN to PDN_UART without
 * a resistor.
 * The drivers can also be used with hardware serial.
 *
 * TMCStepper library is required to use TMC stepper drivers.
 * https://github.com/teemuatlut/TMCStepper
 */
#if HAS_TRINAMIC_CONFIG

  #define HOLD_MULTIPLIER    0.5  // Scales down the holding current from run current

  /**
   * Interpolate microsteps to 256
   * Override for each driver with <driver>_INTERPOLATE settings below
   */
  #define INTERPOLATE      true

  #if AXIS_IS_TMC(X)
    #define X_CURRENT       800        // (mA) RMS current. Multiply by 1.414 for peak current.
    #define X_CURRENT_HOME  X_CURRENT  // (mA) RMS current for sensorless homing
    #define X_MICROSTEPS     16        // 0..256
    #define X_RSENSE          0.11
    #define X_CHAIN_POS      -1        // -1..0: Not chained. 1: MCU MOSI connected. 2: Next in chain, ...
    //#define X_INTERPOLATE  true      // Enable to override 'INTERPOLATE' for the X axis
  #endif

  #if AXIS_IS_TMC(X2)
    #define X2_CURRENT      800
    #define X2_CURRENT_HOME X2_CURRENT
    #define X2_MICROSTEPS    X_MICROSTEPS
```

```
    #define X2_RSENSE          0.11
    #define X2_CHAIN_POS      -1
    //#define X2_INTERPOLATE true
  #endif

  #if AXIS_IS_TMC(Y)
    #define Y_CURRENT       800
    #define Y_CURRENT_HOME  Y_CURRENT
    #define Y_MICROSTEPS     16
    #define Y_RSENSE          0.11
    #define Y_CHAIN_POS      -1
    //#define Y_INTERPOLATE  true
  #endif

  #if AXIS_IS_TMC(Y2)
    #define Y2_CURRENT      800
    #define Y2_CURRENT_HOME Y2_CURRENT
    #define Y2_MICROSTEPS    Y_MICROSTEPS
    #define Y2_RSENSE         0.11
    #define Y2_CHAIN_POS     -1
    //#define Y2_INTERPOLATE true
  #endif

  #if AXIS_IS_TMC(Z)
    #define Z_CURRENT       800
    #define Z_CURRENT_HOME  Z_CURRENT
    #define Z_MICROSTEPS     16
    #define Z_RSENSE          0.11
    #define Z_CHAIN_POS      -1
    //#define Z_INTERPOLATE  true
  #endif

  #if AXIS_IS_TMC(Z2)
    #define Z2_CURRENT      800
    #define Z2_CURRENT_HOME Z2_CURRENT
    #define Z2_MICROSTEPS    Z_MICROSTEPS
    #define Z2_RSENSE         0.11
    #define Z2_CHAIN_POS     -1
    //#define Z2_INTERPOLATE true
  #endif

  #if AXIS_IS_TMC(Z3)
    #define Z3_CURRENT      800
    #define Z3_CURRENT_HOME Z3_CURRENT
    #define Z3_MICROSTEPS    Z_MICROSTEPS
    #define Z3_RSENSE         0.11
    #define Z3_CHAIN_POS     -1
    //#define Z3_INTERPOLATE true
  #endif

  #if AXIS_IS_TMC(Z4)
    #define Z4_CURRENT      800
    #define Z4_CURRENT_HOME Z4_CURRENT
    #define Z4_MICROSTEPS    Z_MICROSTEPS
    #define Z4_RSENSE         0.11
    #define Z4_CHAIN_POS     -1
    //#define Z4_INTERPOLATE true
  #endif
```

```
#if AXIS_IS_TMC(I)
  #define I_CURRENT      800
  #define I_CURRENT_HOME I_CURRENT
  #define I_MICROSTEPS    16
  #define I_RSENSE         0.11
  #define I_CHAIN_POS     -1
  //#define I_INTERPOLATE  true
#endif

#if AXIS_IS_TMC(J)
  #define J_CURRENT      800
  #define J_CURRENT_HOME J_CURRENT
  #define J_MICROSTEPS    16
  #define J_RSENSE         0.11
  #define J_CHAIN_POS     -1
  //#define J_INTERPOLATE  true
#endif

#if AXIS_IS_TMC(K)
  #define K_CURRENT      800
  #define K_CURRENT_HOME K_CURRENT
  #define K_MICROSTEPS    16
  #define K_RSENSE         0.11
  #define K_CHAIN_POS     -1
  //#define K_INTERPOLATE  true
#endif

#if AXIS_IS_TMC(E0)
  #define E0_CURRENT      800
  #define E0_MICROSTEPS    16
  #define E0_RSENSE         0.11
  #define E0_CHAIN_POS     -1
  //#define E0_INTERPOLATE true
#endif

#if AXIS_IS_TMC(E1)
  #define E1_CURRENT      800
  #define E1_MICROSTEPS   E0_MICROSTEPS
  #define E1_RSENSE         0.11
  #define E1_CHAIN_POS     -1
  //#define E1_INTERPOLATE true
#endif

#if AXIS_IS_TMC(E2)
  #define E2_CURRENT      800
  #define E2_MICROSTEPS   E0_MICROSTEPS
  #define E2_RSENSE         0.11
  #define E2_CHAIN_POS     -1
  //#define E2_INTERPOLATE true
#endif

#if AXIS_IS_TMC(E3)
  #define E3_CURRENT      800
  #define E3_MICROSTEPS   E0_MICROSTEPS
  #define E3_RSENSE         0.11
  #define E3_CHAIN_POS     -1
  //#define E3_INTERPOLATE true
#endif
```

```
2722
2723  #if AXIS_IS_TMC(E4)
2724    #define E4_CURRENT      800
2725    #define E4_MICROSTEPS   E0_MICROSTEPS
2726    #define E4_RSENSE         0.11
2727    #define E4_CHAIN_POS     -1
2728    //#define E4_INTERPOLATE true
2729  #endif
2730
2731  #if AXIS_IS_TMC(E5)
2732    #define E5_CURRENT      800
2733    #define E5_MICROSTEPS   E0_MICROSTEPS
2734    #define E5_RSENSE         0.11
2735    #define E5_CHAIN_POS     -1
2736    //#define E5_INTERPOLATE true
2737  #endif
2738
2739  #if AXIS_IS_TMC(E6)
2740    #define E6_CURRENT      800
2741    #define E6_MICROSTEPS   E0_MICROSTEPS
2742    #define E6_RSENSE         0.11
2743    #define E6_CHAIN_POS     -1
2744    //#define E6_INTERPOLATE true
2745  #endif
2746
2747  #if AXIS_IS_TMC(E7)
2748    #define E7_CURRENT      800
2749    #define E7_MICROSTEPS   E0_MICROSTEPS
2750    #define E7_RSENSE         0.11
2751    #define E7_CHAIN_POS     -1
2752    //#define E7_INTERPOLATE true
2753  #endif
2754
2755  /**
2756   * Override default SPI pins for TMC2130, TMC2160, TMC2660, TMC5130 and
     TMC5160 drivers here.
2757   * The default pins can be found in your board's pins file.
2758   */
2759  //#define X_CS_PIN          -1
2760  //#define Y_CS_PIN          -1
2761  //#define Z_CS_PIN          -1
2762  //#define X2_CS_PIN         -1
2763  //#define Y2_CS_PIN         -1
2764  //#define Z2_CS_PIN         -1
2765  //#define Z3_CS_PIN         -1
2766  //#define Z4_CS_PIN         -1
2767  //#define I_CS_PIN          -1
2768  //#define J_CS_PIN          -1
2769  //#define K_CS_PIN          -1
2770  //#define E0_CS_PIN         -1
2771  //#define E1_CS_PIN         -1
2772  //#define E2_CS_PIN         -1
2773  //#define E3_CS_PIN         -1
2774  //#define E4_CS_PIN         -1
2775  //#define E5_CS_PIN         -1
2776  //#define E6_CS_PIN         -1
2777  //#define E7_CS_PIN         -1
2778
```

```
  /**
   * Software option for SPI driven drivers (TMC2130, TMC2160, TMC2660, TMC5130 and TMC5160).
   * The default SW SPI pins are defined the respective pins files,
   * but you can override or define them here.
   */
  //#define TMC_USE_SW_SPI
  //#define TMC_SW_MOSI       -1
  //#define TMC_SW_MISO       -1
  //#define TMC_SW_SCK        -1

  /**
   * Four TMC2209 drivers can use the same HW/SW serial port with hardware configured addresses.
   * Set the address using jumpers on pins MS1 and MS2.
   * Address | MS1  | MS2
   *       0 | LOW  | LOW
   *       1 | HIGH | LOW
   *       2 | LOW  | HIGH
   *       3 | HIGH | HIGH
   *
   * Set *_SERIAL_TX_PIN and *_SERIAL_RX_PIN to match for all drivers
   * on the same serial port, either here or in your board's pins file.
   */
  //#define  X_SLAVE_ADDRESS 0
  //#define  Y_SLAVE_ADDRESS 0
  //#define  Z_SLAVE_ADDRESS 0
  //#define X2_SLAVE_ADDRESS 0
  //#define Y2_SLAVE_ADDRESS 0
  //#define Z2_SLAVE_ADDRESS 0
  //#define Z3_SLAVE_ADDRESS 0
  //#define Z4_SLAVE_ADDRESS 0
  //#define  I_SLAVE_ADDRESS 0
  //#define  J_SLAVE_ADDRESS 0
  //#define  K_SLAVE_ADDRESS 0
  //#define E0_SLAVE_ADDRESS 0
  //#define E1_SLAVE_ADDRESS 0
  //#define E2_SLAVE_ADDRESS 0
  //#define E3_SLAVE_ADDRESS 0
  //#define E4_SLAVE_ADDRESS 0
  //#define E5_SLAVE_ADDRESS 0
  //#define E6_SLAVE_ADDRESS 0
  //#define E7_SLAVE_ADDRESS 0

  /**
   * Software enable
   *
   * Use for drivers that do not use a dedicated enable pin, but rather handle the same
   * function through a communication line such as SPI or UART.
   */
  //#define SOFTWARE_DRIVER_ENABLE

  /**
   * TMC2130, TMC2160, TMC2208, TMC2209, TMC5130 and TMC5160 only
   * Use Trinamic's ultra quiet stepping mode.
   * When disabled, Marlin will use spreadCycle stepping mode.
   */
  #define STEALTHCHOP_XY
```

```
  #define STEALTHCHOP_Z
  #define STEALTHCHOP_I
  #define STEALTHCHOP_J
  #define STEALTHCHOP_K
  #define STEALTHCHOP_E

  /**
   * Optimize spreadCycle chopper parameters by using predefined parameter sets
   * or with the help of an example included in the library.
   * Provided parameter sets are
   * CHOPPER_DEFAULT_12V
   * CHOPPER_DEFAULT_19V
   * CHOPPER_DEFAULT_24V
   * CHOPPER_DEFAULT_36V
   * CHOPPER_09STEP_24V   // 0.9 degree steppers (24V)
   * CHOPPER_PRUSAMK3_24V // Imported parameters from the official Průša firmware for MK3 (24V)
   * CHOPPER_MARLIN_119   // Old defaults from Marlin v1.1.9
   *
   * Define your own with:
   * { <off_time[1..15]>, <hysteresis_end[-3..12]>, hysteresis_start[1..8] }
   */
  #define CHOPPER_TIMING CHOPPER_DEFAULT_12V       // All axes (override below)
  //#define CHOPPER_TIMING_X  CHOPPER_TIMING       // For X Axes (override below)
  //#define CHOPPER_TIMING_X2 CHOPPER_TIMING_X
  //#define CHOPPER_TIMING_Y  CHOPPER_TIMING       // For Y Axes (override below)
  //#define CHOPPER_TIMING_Y2 CHOPPER_TIMING_Y
  //#define CHOPPER_TIMING_Z  CHOPPER_TIMING       // For Z Axes (override below)
  //#define CHOPPER_TIMING_Z2 CHOPPER_TIMING_Z
  //#define CHOPPER_TIMING_Z3 CHOPPER_TIMING_Z
  //#define CHOPPER_TIMING_Z4 CHOPPER_TIMING_Z
  //#define CHOPPER_TIMING_E  CHOPPER_TIMING       // For Extruders (override below)
  //#define CHOPPER_TIMING_E1 CHOPPER_TIMING_E
  //#define CHOPPER_TIMING_E2 CHOPPER_TIMING_E
  //#define CHOPPER_TIMING_E3 CHOPPER_TIMING_E
  //#define CHOPPER_TIMING_E4 CHOPPER_TIMING_E
  //#define CHOPPER_TIMING_E5 CHOPPER_TIMING_E
  //#define CHOPPER_TIMING_E6 CHOPPER_TIMING_E
  //#define CHOPPER_TIMING_E7 CHOPPER_TIMING_E

  /**
   * Monitor Trinamic drivers
   * for error conditions like overtemperature and short to ground.
   * To manage over-temp Marlin can decrease the driver current until the error condition clears.
   * Other detected conditions can be used to stop the current print.
   * Relevant G-codes:
   * M906 - Set or get motor current in milliamps using axis codes X, Y, Z, E. Report values if no axis codes given.
   * M911 - Report stepper driver overtemperature pre-warn condition.
   * M912 - Clear stepper driver overtemperature pre-warn condition flag.
   * M122 - Report driver parameters (Requires TMC_DEBUG)
```

```
   */
  //#define MONITOR_DRIVER_STATUS

  #if ENABLED(MONITOR_DRIVER_STATUS)
    #define CURRENT_STEP_DOWN     50  // [mA]
    #define REPORT_CURRENT_CHANGE
    #define STOP_ON_ERROR
  #endif

  /**
   * TMC2130, TMC2160, TMC2208, TMC2209, TMC5130 and TMC5160 only
   * The driver will switch to spreadCycle when stepper speed is over HYBRID_THRESHOLD.
   * This mode allows for faster movements at the expense of higher noise levels.
   * STEALTHCHOP_(XY|Z|E) must be enabled to use HYBRID_THRESHOLD.
   * M913 X/Y/Z/E to live tune the setting
   */
  //#define HYBRID_THRESHOLD

  #define X_HYBRID_THRESHOLD     100  // [mm/s]
  #define X2_HYBRID_THRESHOLD    100
  #define Y_HYBRID_THRESHOLD     100
  #define Y2_HYBRID_THRESHOLD    100
  #define Z_HYBRID_THRESHOLD       3
  #define Z2_HYBRID_THRESHOLD      3
  #define Z3_HYBRID_THRESHOLD      3
  #define Z4_HYBRID_THRESHOLD      3
  #define I_HYBRID_THRESHOLD       3
  #define J_HYBRID_THRESHOLD       3
  #define K_HYBRID_THRESHOLD       3
  #define E0_HYBRID_THRESHOLD     30
  #define E1_HYBRID_THRESHOLD     30
  #define E2_HYBRID_THRESHOLD     30
  #define E3_HYBRID_THRESHOLD     30
  #define E4_HYBRID_THRESHOLD     30
  #define E5_HYBRID_THRESHOLD     30
  #define E6_HYBRID_THRESHOLD     30
  #define E7_HYBRID_THRESHOLD     30

  /**
   * Use StallGuard to home / probe X, Y, Z.
   *
   * TMC2130, TMC2160, TMC2209, TMC2660, TMC5130, and TMC5160 only
   * Connect the stepper driver's DIAG1 pin to the X/Y endstop pin.
   * X, Y, and Z homing will always be done in spreadCycle mode.
   *
   * X/Y/Z_STALL_SENSITIVITY is the default stall threshold.
   * Use M914 X Y Z to set the stall threshold at runtime:
   *
   *  Sensitivity   TMC2209   Others
   *    HIGHEST       255      -64    (Too sensitive => False positive)
   *    LOWEST          0       63    (Too insensitive => No trigger)
   *
   * It is recommended to set HOMING_BUMP_MM to { 0, 0, 0 }.
   *
   * SPI_ENDSTOPS  *** Beta feature! *** TMC2130/TMC5160 Only ***
   * Poll the driver through SPI to determine load when homing.
   * Removes the need for a wire from DIAG1 to an endstop pin.
```

```
   * Reduces the need for a wire from DIAG to an endstop pin.
   *
   * IMPROVE_HOMING_RELIABILITY tunes acceleration and jerk when
   * homing and adds a guard period for endstop triggering.
   *
   * Comment *_STALL_SENSITIVITY to disable sensorless homing for that axis.
   */
  //#define SENSORLESS_HOMING // StallGuard capable drivers only

  #if EITHER(SENSORLESS_HOMING, SENSORLESS_PROBING)
    // TMC2209: 0...255. TMC2130: -64...63
    #define X_STALL_SENSITIVITY  8
    #define X2_STALL_SENSITIVITY X_STALL_SENSITIVITY
    #define Y_STALL_SENSITIVITY  8
    #define Y2_STALL_SENSITIVITY Y_STALL_SENSITIVITY
    //#define Z_STALL_SENSITIVITY  8
    //#define Z2_STALL_SENSITIVITY Z_STALL_SENSITIVITY
    //#define Z3_STALL_SENSITIVITY Z_STALL_SENSITIVITY
    //#define Z4_STALL_SENSITIVITY Z_STALL_SENSITIVITY
    //#define I_STALL_SENSITIVITY  8
    //#define J_STALL_SENSITIVITY  8
    //#define K_STALL_SENSITIVITY  8
    //#define SPI_ENDSTOPS              // TMC2130 only
    //#define IMPROVE_HOMING_RELIABILITY
  #endif

  /**
   * TMC Homing stepper phase.
   *
   * Improve homing repeatability by homing to stepper coil's nearest absolute
   * phase position. Trinamic drivers use a stepper phase table with 1024 values
   * spanning 4 full steps with 256 positions each (ergo, 1024 positions).
   * Full step positions (128, 384, 640, 896) have the highest holding torque.
   *
   * Values from 0..1023, -1 to disable homing phase for that axis.
   */
   //#define TMC_HOME_PHASE { 896, 896, 896 }

  /**
   * Beta feature!
   * Create a 50/50 square wave step pulse optimal for stepper drivers.
   */
  //#define SQUARE_WAVE_STEPPING

  /**
   * Enable M122 debugging command for TMC stepper drivers.
   * M122 S0/1 will enable continuous reporting.
   */
  //#define TMC_DEBUG

  /**
   * You can set your own advanced settings by filling in predefined functions.
   * A list of available functions can be found on the library github page
   * https://github.com/teemuatlut/TMCStepper
   *
```

```
   * Example:
   * #define TMC_ADV() { \
   *   stepperX.diag0_otpw(1); \
   *   stepperY.intpol(0); \
   * }
   */
  #define TMC_ADV() {  }

#endif // HAS_TRINAMIC_CONFIG

// @section L64XX

/**
 * L64XX Stepper Driver options
 *
 * Arduino-L6470 library (0.8.0 or higher) is required.
 * https://github.com/ameyer/Arduino-L6470
 *
 * Requires the following to be defined in your pins_YOUR_BOARD file
 *     L6470_CHAIN_SCK_PIN
 *     L6470_CHAIN_MISO_PIN
 *     L6470_CHAIN_MOSI_PIN
 *     L6470_CHAIN_SS_PIN
 *     ENABLE_RESET_L64XX_CHIPS(Q)  where Q is 1 to enable and 0 to reset
 */

#if HAS_L64XX

  //#define L6470_CHITCHAT        // Display additional status info

  #if AXIS_IS_L64XX(X)
    #define X_MICROSTEPS       128  // Number of microsteps (VALID: 1, 2, 4, 8, 16, 32, 128) - L6474 max is 16
    #define X_OVERCURRENT     2000  // (mA) Current where the driver detects an over current
                                    //   L6470 & L6474 - VALID: 375 x (1 - 16) - 6A max - rounds down
                                    //   POWERSTEP01: VALID: 1000 x (1 - 32) - 32A max - rounds down
    #define X_STALLCURRENT    1500  // (mA) Current where the driver detects a stall (VALID: 31.25 * (1-128) -  4A max - rounds down)
                                    //   L6470 & L6474 - VALID: 31.25 * (1-128) -  4A max - rounds down
                                    //   POWERSTEP01: VALID: 200 x (1 - 32) - 6.4A max - rounds down
                                    //   L6474 - STALLCURRENT setting is used to set the nominal (TVAL) current
    #define X_MAX_VOLTAGE      127  // 0-255, Maximum effective voltage seen by stepper - not used by L6474
    #define X_CHAIN_POS         -1  // Position in SPI chain, 0=Not in chain, 1=Nearest MOSI
    #define X_SLEW_RATE          1  // 0-3, Slew 0 is slowest, 3 is fastest
  #endif

  #if AXIS_IS_L64XX(X2)
    #define X2_MICROSTEPS     X_MICROSTEPS
    #define X2_OVERCURRENT            2000
    #define X2_STALLCURRENT           1500
    #define X2_MAX_VOLTAGE             127
```

```
    #define X2_CHAIN_POS              -1
    #define X2_SLEW_RATE               1
  #endif

  #if AXIS_IS_L64XX(Y)
    #define Y_MICROSTEPS             128
    #define Y_OVERCURRENT           2000
    #define Y_STALLCURRENT          1500
    #define Y_MAX_VOLTAGE            127
    #define Y_CHAIN_POS               -1
    #define Y_SLEW_RATE                1
  #endif

  #if AXIS_IS_L64XX(Y2)
    #define Y2_MICROSTEPS     Y_MICROSTEPS
    #define Y2_OVERCURRENT          2000
    #define Y2_STALLCURRENT         1500
    #define Y2_MAX_VOLTAGE           127
    #define Y2_CHAIN_POS              -1
    #define Y2_SLEW_RATE               1
  #endif

  #if AXIS_IS_L64XX(Z)
    #define Z_MICROSTEPS             128
    #define Z_OVERCURRENT           2000
    #define Z_STALLCURRENT          1500
    #define Z_MAX_VOLTAGE            127
    #define Z_CHAIN_POS               -1
    #define Z_SLEW_RATE                1
  #endif

  #if AXIS_IS_L64XX(Z2)
    #define Z2_MICROSTEPS     Z_MICROSTEPS
    #define Z2_OVERCURRENT          2000
    #define Z2_STALLCURRENT         1500
    #define Z2_MAX_VOLTAGE           127
    #define Z2_CHAIN_POS              -1
    #define Z2_SLEW_RATE               1
  #endif

  #if AXIS_IS_L64XX(Z3)
    #define Z3_MICROSTEPS     Z_MICROSTEPS
    #define Z3_OVERCURRENT          2000
    #define Z3_STALLCURRENT         1500
    #define Z3_MAX_VOLTAGE           127
    #define Z3_CHAIN_POS              -1
    #define Z3_SLEW_RATE               1
  #endif

  #if AXIS_IS_L64XX(Z4)
    #define Z4_MICROSTEPS     Z_MICROSTEPS
    #define Z4_OVERCURRENT          2000
    #define Z4_STALLCURRENT         1500
    #define Z4_MAX_VOLTAGE           127
    #define Z4_CHAIN_POS              -1
    #define Z4_SLEW_RATE               1
  #endif
```

```
#if AXIS_DRIVER_TYPE_I(L6470)
  #define I_MICROSTEPS      128
  #define I_OVERCURRENT    2000
  #define I_STALLCURRENT   1500
  #define I_MAX_VOLTAGE     127
  #define I_CHAIN_POS        -1
  #define I_SLEW_RATE         1
#endif

#if AXIS_DRIVER_TYPE_J(L6470)
  #define J_MICROSTEPS      128
  #define J_OVERCURRENT    2000
  #define J_STALLCURRENT   1500
  #define J_MAX_VOLTAGE     127
  #define J_CHAIN_POS        -1
  #define J_SLEW_RATE         1
#endif

#if AXIS_DRIVER_TYPE_K(L6470)
  #define K_MICROSTEPS      128
  #define K_OVERCURRENT    2000
  #define K_STALLCURRENT   1500
  #define K_MAX_VOLTAGE     127
  #define K_CHAIN_POS        -1
  #define K_SLEW_RATE         1
#endif

#if AXIS_IS_L64XX(E0)
  #define E0_MICROSTEPS             128
  #define E0_OVERCURRENT           2000
  #define E0_STALLCURRENT          1500
  #define E0_MAX_VOLTAGE            127
  #define E0_CHAIN_POS               -1
  #define E0_SLEW_RATE                1
#endif

#if AXIS_IS_L64XX(E1)
  #define E1_MICROSTEPS    E0_MICROSTEPS
  #define E1_OVERCURRENT           2000
  #define E1_STALLCURRENT          1500
  #define E1_MAX_VOLTAGE            127
  #define E1_CHAIN_POS               -1
  #define E1_SLEW_RATE                1
#endif

#if AXIS_IS_L64XX(E2)
  #define E2_MICROSTEPS    E0_MICROSTEPS
  #define E2_OVERCURRENT           2000
  #define E2_STALLCURRENT          1500
  #define E2_MAX_VOLTAGE            127
  #define E2_CHAIN_POS               -1
  #define E2_SLEW_RATE                1
#endif

#if AXIS_IS_L64XX(E3)
  #define E3_MICROSTEPS    E0_MICROSTEPS
  #define E3_OVERCURRENT           2000
  #define E3_STALLCURRENT          1500
  #define E3_MAX_VOLTAGE            127
```

```
    #define E3_CHAIN_POS                -1
    #define E3_SLEW_RATE                 1
  #endif

  #if AXIS_IS_L64XX(E4)
    #define E4_MICROSTEPS    E0_MICROSTEPS
    #define E4_OVERCURRENT            2000
    #define E4_STALLCURRENT           1500
    #define E4_MAX_VOLTAGE             127
    #define E4_CHAIN_POS                -1
    #define E4_SLEW_RATE                 1
  #endif

  #if AXIS_IS_L64XX(E5)
    #define E5_MICROSTEPS    E0_MICROSTEPS
    #define E5_OVERCURRENT            2000
    #define E5_STALLCURRENT           1500
    #define E5_MAX_VOLTAGE             127
    #define E5_CHAIN_POS                -1
    #define E5_SLEW_RATE                 1
  #endif

  #if AXIS_IS_L64XX(E6)
    #define E6_MICROSTEPS    E0_MICROSTEPS
    #define E6_OVERCURRENT            2000
    #define E6_STALLCURRENT           1500
    #define E6_MAX_VOLTAGE             127
    #define E6_CHAIN_POS                -1
    #define E6_SLEW_RATE                 1
  #endif

  #if AXIS_IS_L64XX(E7)
    #define E7_MICROSTEPS    E0_MICROSTEPS
    #define E7_OVERCURRENT            2000
    #define E7_STALLCURRENT           1500
    #define E7_MAX_VOLTAGE             127
    #define E7_CHAIN_POS                -1
    #define E7_SLEW_RATE                 1
  #endif

  /**
   * Monitor L6470 drivers for error conditions like over temperature and over current.
   * In the case of over temperature Marlin can decrease the drive until the error condition clears.
   * Other detected conditions can be used to stop the current print.
   * Relevant G-codes:
   * M906 - I1/2/3/4/5  Set or get motor drive level using axis codes X, Y, Z, E. Report values if no axis codes given.
   *         I not present or I0 or I1 - X, Y, Z or E0
   *         I2 - X2, Y2, Z2 or E1
   *         I3 - Z3 or E3
   *         I4 - Z4 or E4
   *         I5 - E5
   * M916 - Increase drive level until get thermal warning
   * M917 - Find minimum current thresholds
   * M918 - Increase speed until max or error
   * M122 S0/1 - Report driver parameters
```

```
   */
  //#define MONITOR_L6470_DRIVER_STATUS

  #if ENABLED(MONITOR_L6470_DRIVER_STATUS)
    #define KVAL_HOLD_STEP_DOWN     1
    //#define L6470_STOP_ON_ERROR
  #endif

#endif // HAS_L64XX

// @section i2cbus

//
// I2C Master ID for LPC176x LCD and Digital Current control
// Does not apply to other peripherals based on the Wire library.
//
//#define I2C_MASTER_ID  1  // Set a value from 0 to 2

/**
 * TWI/I2C BUS
 *
 * This feature is an EXPERIMENTAL feature so it shall not be used on production
 * machines. Enabling this will allow you to send and receive I2C data from slave
 * devices on the bus.
 *
 * ; Example #1
 * ; This macro send the string "Marlin" to the slave device with address 0x63 (99)
 * ; It uses multiple M260 commands with one B<base 10> arg
 * M260 A99  ; Target slave address
 * M260 B77  ; M
 * M260 B97  ; a
 * M260 B114 ; r
 * M260 B108 ; l
 * M260 B105 ; i
 * M260 B110 ; n
 * M260 S1   ; Send the current buffer
 *
 * ; Example #2
 * ; Request 6 bytes from slave device with address 0x63 (99)
 * M261 A99 B5
 *
 * ; Example #3
 * ; Example serial output of a M261 request
 * echo:i2c-reply: from:99 bytes:5 data:hello
 */

//#define EXPERIMENTAL_I2CBUS
#if ENABLED(EXPERIMENTAL_I2CBUS)
  #define I2C_SLAVE_ADDRESS  0  // Set a value from 8 to 127 to act as a slave
#endif

// @section extras

/**
 * Photo G-code
```

```
 * Photo G-code
 * Add the M240 G-code to take a photo.
 * The photo can be triggered by a digital pin or a physical movement.
 */
//#define PHOTO_GCODE
#if ENABLED(PHOTO_GCODE)
  // A position to move to (and raise Z) before taking the photo
  //#define PHOTO_POSITION { X_MAX_POS - 5, Y_MAX_POS, 0 }  // { xpos, ypos, zraise } (M240 X Y Z)
  //#define PHOTO_DELAY_MS   100                            // (ms) Duration to pause before moving back (M240 P)
  //#define PHOTO_RETRACT_MM   6.5                          // (mm) E retract/recover for the photo move (M240 R S)

  // Canon RC-1 or homebrew digital camera trigger
  // Data from: https://www.doc-diy.net/photo/rc-1_hacked/
  //#define PHOTOGRAPH_PIN 23

  // Canon Hack Development Kit
  // https://captain-slow.dk/2014/03/09/3d-printing-timelapses/
  //#define CHDK_PIN        4

  // Optional second move with delay to trigger the camera shutter
  //#define PHOTO_SWITCH_POSITION { X_MAX_POS, Y_MAX_POS }  // { xpos, ypos } (M240 I J)

  // Duration to hold the switch or keep CHDK_PIN high
  //#define PHOTO_SWITCH_MS   50 // (ms) (M240 D)

  /**
   * PHOTO_PULSES_US may need adjustment depending on board and camera model.
   * Pin must be running at 48.4kHz.
   * Be sure to use a PHOTOGRAPH_PIN which can rise and fall quick enough.
   * (e.g., MKS SBase temp sensor pin was too slow, so used P1.23 on J8.)
   *
   *  Example pulse data for Nikon: https://bit.ly/2FKD0Aq
   *                     IR Wiring: https://git.io/JvJf7
   */
  //#define PHOTO_PULSES_US { 2000, 27850, 400, 1580, 400, 3580, 400 }  // (µs) Durations for each 48.4kHz oscillation
  #ifdef PHOTO_PULSES_US
    #define PHOTO_PULSE_DELAY_US 13 // (µs) Approximate duration of each HIGH and LOW pulse in the oscillation
  #endif
#endif

/**
 * Spindle & Laser control
 *
 * Add the M3, M4, and M5 commands to turn the spindle/laser on and off, and
 * to set spindle speed, spindle direction, and laser power.
 *
 * SuperPid is a router/spindle speed controller used in the CNC milling community.
 * Marlin can be used to turn the spindle on and off. It can also be used to set
 * the spindle speed from 5,000 to 30,000 RPM.
 *
```

```
 * You'll need to select a pin for the ON/OFF function and optionally choose a 0-5V
 * hardware PWM pin for the speed control and a pin for the rotation direction.
 *
 * See https://marlinfw.org/docs/configuration/laser_spindle.html for more config details.
 */
//#define SPINDLE_FEATURE
//#define LASER_FEATURE
#if EITHER(SPINDLE_FEATURE, LASER_FEATURE)
  #define SPINDLE_LASER_ACTIVE_STATE    LOW    // Set to "HIGH" if SPINDLE_LASER_ENA_PIN is active HIGH

  #define SPINDLE_LASER_USE_PWM                // Enable if your controller supports setting the speed/power
  #if ENABLED(SPINDLE_LASER_USE_PWM)
    #define SPINDLE_LASER_PWM_INVERT    false  // Set to "true" if the speed/power goes up when you want it to go slower
    #define SPINDLE_LASER_FREQUENCY     2500   // (Hz) Spindle/laser frequency (only on supported HALs: AVR and LPC)
  #endif

  //#define AIR_EVACUATION                     // Cutter Vacuum / Laser Blower motor control with G-codes M10-M11
  #if ENABLED(AIR_EVACUATION)
    #define AIR_EVACUATION_ACTIVE       LOW    // Set to "HIGH" if the on/off function is active HIGH
    //#define AIR_EVACUATION_PIN        42     // Override the default Cutter Vacuum or Laser Blower pin
  #endif

  //#define AIR_ASSIST                         // Air Assist control with G-codes M8-M9
  #if ENABLED(AIR_ASSIST)
    #define AIR_ASSIST_ACTIVE           LOW    // Active state on air assist pin
    //#define AIR_ASSIST_PIN            44     // Override the default Air Assist pin
  #endif

  //#define SPINDLE_SERVO                      // A servo converting an angle to spindle power
  #ifdef SPINDLE_SERVO
    #define SPINDLE_SERVO_NR   0               // Index of servo used for spindle control
    #define SPINDLE_SERVO_MIN 10               // Minimum angle for servo spindle
  #endif

  /**
   * Speed / Power can be set ('M3 S') and displayed in terms of:
   *  - PWM255  (S0 - S255)
   *  - PERCENT (S0 - S100)
   *  - RPM     (S0 - S50000)  Best for use with a spindle
   *  - SERVO   (S0 - S180)
   */
  #define CUTTER_POWER_UNIT PWM255
```

```
  /**
   * Relative Cutter Power
   * Normally, 'M3 O<power>' sets
   * OCR power is relative to the range SPEED_POWER_MIN...SPEED_POWER_MAX.
   * so input powers of 0...255 correspond to
SPEED_POWER_MIN...SPEED_POWER_MAX
   * instead of normal range (0 to SPEED_POWER_MAX).
   * Best used with (e.g.) SuperPID router controller: S0 = 5,000 RPM and
S255 = 30,000 RPM
   */
  //#define CUTTER_POWER_RELATIVE             // Set speed proportional to
[SPEED_POWER_MIN...SPEED_POWER_MAX]

  #if ENABLED(SPINDLE_FEATURE)
    //#define SPINDLE_CHANGE_DIR              // Enable if your spindle
controller can change spindle direction
    #define SPINDLE_CHANGE_DIR_STOP           // Enable if the spindle
should stop before changing spin direction
    #define SPINDLE_INVERT_DIR          false  // Set to "true" if the spin
direction is reversed

    #define SPINDLE_LASER_POWERUP_DELAY   5000 // (ms) Delay to allow the
spindle/laser to come up to speed/power
    #define SPINDLE_LASER_POWERDOWN_DELAY 5000 // (ms) Delay to allow the
spindle to stop

    /**
     * M3/M4 Power Equation
     *
     * Each tool uses different value ranges for speed / power control.
     * These parameters are used to convert between tool power units and
PWM.
     *
     * Speed/Power = (PWMDC / 255 * 100 - SPEED_POWER_INTERCEPT) /
SPEED_POWER_SLOPE
     * PWMDC = (spdpwr - SPEED_POWER_MIN) / (SPEED_POWER_MAX -
SPEED_POWER_MIN) / SPEED_POWER_SLOPE
     */
    #if ENABLED(SPINDLE_LASER_USE_PWM)
      #define SPEED_POWER_INTERCEPT       0    // (%) 0-100 i.e., Minimum
power percentage
      #define SPEED_POWER_MIN          5000    // (RPM)
      #define SPEED_POWER_MAX         30000    // (RPM) SuperPID router
controller 0 - 30,000 RPM
      #define SPEED_POWER_STARTUP     25000    // (RPM) M3/M4 speed/power
default (with no arguments)
    #endif

  #else

    #if ENABLED(SPINDLE_LASER_USE_PWM)
      #define SPEED_POWER_INTERCEPT       0    // (%) 0-100 i.e., Minimum
power percentage
      #define SPEED_POWER_MIN             0    // (%) 0-100
      #define SPEED_POWER_MAX           100    // (%) 0-100
      #define SPEED_POWER_STARTUP        80    // (%) M3/M4 speed/power
default (with no arguments)
    #endif
```

```
3405
3406      // Define the minimum and maximum test pulse time values for a laser test fire function
3407      #define LASER_TEST_PULSE_MIN           1   // Used with Laser Control Menu
3408      #define LASER_TEST_PULSE_MAX         999   // Caution: Menu may not show more than 3 characters
3409
3410      /**
3411       * Enable inline laser power to be handled in the planner / stepper routines.
3412       * Inline power is specified by the I (inline) flag in an M3 command (e.g., M3 S20 I)
3413       * or by the 'S' parameter in G0/G1/G2/G3 moves (see LASER_MOVE_POWER).
3414       *
3415       * This allows the laser to keep in perfect sync with the planner and removes
3416       * the powerup/down delay since lasers require negligible time.
3417       */
3418      //#define LASER_POWER_INLINE
3419
3420      #if ENABLED(LASER_POWER_INLINE)
3421        /**
3422         * Scale the laser's power in proportion to the movement rate.
3423         *
3424         * - Sets the entry power proportional to the entry speed over the nominal speed.
3425         * - Ramps the power up every N steps to approximate the speed trapezoid.
3426         * - Due to the limited power resolution this is only approximate.
3427         */
3428        #define LASER_POWER_INLINE_TRAPEZOID
3429
3430        /**
3431         * Continuously calculate the current power (nominal_power * current_rate / nominal_rate).
3432         * Required for accurate power with non-trapezoidal acceleration (e.g., S_CURVE_ACCELERATION).
3433         * This is a costly calculation so this option is discouraged on 8-bit AVR boards.
3434         *
3435         * LASER_POWER_INLINE_TRAPEZOID_CONT_PER defines how many step cycles there are between power updates. If your
3436         * board isn't able to generate steps fast enough (and you are using LASER_POWER_INLINE_TRAPEZOID_CONT), increase this.
3437         * Note that when this is zero it means it occurs every cycle; 1 means a delay wait one cycle then run, etc.
3438         */
3439        //#define LASER_POWER_INLINE_TRAPEZOID_CONT
3440
3441        /**
3442         * Stepper iterations between power updates. Increase this value if the board
3443         * can't keep up with the processing demands of LASER_POWER_INLINE_TRAPEZOID_CONT.
3444         * Disable (or set to 0) to recalculate power on every stepper iteration.
3445         */
3446        //#define LASER_POWER_INLINE_TRAPEZOID_CONT_PER 10
```

```
      //#define LASER_POWER_INLINE_TRAPEZOID_CONT_PER 10

      /**
       * Include laser power in G0/G1/G2/G3/G5 commands with the 'S' parameter
       */
      //#define LASER_MOVE_POWER

      #if ENABLED(LASER_MOVE_POWER)
        // Turn off the laser on G0 moves with no power parameter.
        // If a power parameter is provided, use that instead.
        //#define LASER_MOVE_G0_OFF

        // Turn off the laser on G28 homing.
        //#define LASER_MOVE_G28_OFF
      #endif

      /**
       * Inline flag inverted
       *
       * WARNING: M5 will NOT turn off the laser unless another move
       *          is done (so G-code files must end with 'M5 I').
       */
      //#define LASER_POWER_INLINE_INVERT

      /**
       * Continuously apply inline power. ('M3 S3' == 'G1 S3' == 'M3 S3 I')
       *
       * The laser might do some weird things, so only enable this
       * feature if you understand the implications.
       */
      //#define LASER_POWER_INLINE_CONTINUOUS

    #else

      #define SPINDLE_LASER_POWERUP_DELAY     50 // (ms) Delay to allow the spindle/laser to come up to speed/power
      #define SPINDLE_LASER_POWERDOWN_DELAY   50 // (ms) Delay to allow the spindle to stop

    #endif

    //
    // Laser I2C Ammeter (High precision INA226 low/high side module)
    //
    //#define I2C_AMMETER
    #if ENABLED(I2C_AMMETER)
      #define I2C_AMMETER_IMAX            0.1    // (Amps) Calibration value for the expected current range
      #define I2C_AMMETER_SHUNT_RESISTOR  0.1    // (Ohms) Calibration shunt resistor value
    #endif

  #endif
#endif // SPINDLE_FEATURE || LASER_FEATURE

/**
 * Synchronous Laser Control with M106/M107
 *
```

```
 * Marlin normally applies M106/M107 fan speeds at a time "soon after" processing
 * a planner block. This is too inaccurate for a PWM/TTL laser attached to the fan
 * header (as with some add-on laser kits). Enable this option to set fan/laser
 * speeds with much more exact timing for improved print fidelity.
 *
 * NOTE: This option sacrifices some cooling fan speed options.
 */
//#define LASER_SYNCHRONOUS_M106_M107

/**
 * Coolant Control
 *
 * Add the M7, M8, and M9 commands to turn mist or flood coolant on and off.
 *
 * Note: COOLANT_MIST_PIN and/or COOLANT_FLOOD_PIN must also be defined.
 */
//#define COOLANT_CONTROL
#if ENABLED(COOLANT_CONTROL)
  #define COOLANT_MIST               // Enable if mist coolant is present
  #define COOLANT_FLOOD              // Enable if flood coolant is present
  #define COOLANT_MIST_INVERT  false  // Set "true" if the on/off function is reversed
  #define COOLANT_FLOOD_INVERT false  // Set "true" if the on/off function is reversed
#endif

/**
 * Filament Width Sensor
 *
 * Measures the filament width in real-time and adjusts
 * flow rate to compensate for any irregularities.
 *
 * Also allows the measured filament diameter to set the
 * extrusion rate, so the slicer only has to specify the
 * volume.
 *
 * Only a single extruder is supported at this time.
 *
 *  34 RAMPS_14    : Analog input 5 on the AUX2 connector
 *  81 PRINTRBOARD : Analog input 2 on the Exp1 connector (version B,C,D,E)
 * 301 RAMBO       : Analog input 3
 *
 * Note: May require analog pins to be defined for other boards.
 */
//#define FILAMENT_WIDTH_SENSOR

#if ENABLED(FILAMENT_WIDTH_SENSOR)
  #define FILAMENT_SENSOR_EXTRUDER_NUM 0    // Index of the extruder that has the filament sensor. :[0,1,2,3,4]
  #define MEASUREMENT_DELAY_CM        14    // (cm) The distance from the filament sensor to the melting chamber

  #define FILWIDTH_ERROR_MARGIN        1.0  // (mm) If a measurement differs too much from nominal width ignore it
  #define MAX_MEASUREMENT_DELAY       20    // (bytes) Buffer size for
```

```
stored measurements (1 byte per cm). Must be larger than
MEASUREMENT_DELAY_CM.

  #define DEFAULT_MEASURED_FILAMENT_DIA DEFAULT_NOMINAL_FILAMENT_DIA // Set
measured to nominal initially

  // Display filament width on the LCD status line. Status messages will
expire after 5 seconds.
  //#define FILAMENT_LCD_DISPLAY
#endif

/**
 * Power Monitor
 * Monitor voltage (V) and/or current (A), and -when possible- power (W)
 *
 * Read and configure with M430
 *
 * The current sensor feeds DC voltage (relative to the measured current) to
an analog pin
 * The voltage sensor feeds DC voltage (relative to the measured voltage) to
an analog pin
 */
//#define POWER_MONITOR_CURRENT   // Monitor the system current
//#define POWER_MONITOR_VOLTAGE   // Monitor the system voltage

#if ENABLED(POWER_MONITOR_CURRENT)
  #define POWER_MONITOR_VOLTS_PER_AMP    0.05000  // Input voltage to the
MCU analog pin per amp  - DO NOT apply more than ADC_VREF!
  #define POWER_MONITOR_CURRENT_OFFSET   0        // Offset (in amps)
applied to the calculated current
  #define POWER_MONITOR_FIXED_VOLTAGE   13.6      // Voltage for a current
sensor with no voltage sensor (for power display)
#endif

#if ENABLED(POWER_MONITOR_VOLTAGE)
  #define POWER_MONITOR_VOLTS_PER_VOLT  0.077933  // Input voltage to the
MCU analog pin per volt - DO NOT apply more than ADC_VREF!
  #define POWER_MONITOR_VOLTAGE_OFFSET  0         // Offset (in volts)
applied to the calculated voltage
#endif

/**
 * Stepper Driver Anti-SNAFU Protection
 *
 * If the SAFE_POWER_PIN is defined for your board, Marlin will check
 * that stepper drivers are properly plugged in before applying power.
 * Disable protection if your stepper drivers don't support the feature.
 */
//#define DISABLE_DRIVER_SAFE_POWER_PROTECT

/**
 * CNC Coordinate Systems
 *
 * Enables G53 and G54-G59.3 commands to select coordinate systems
 * and G92.1 to reset the workspace to native machine space.
 */
//#define CNC_COORDINATE_SYSTEMS

/**
```

```
 * Auto-report temperatures with M155 S<seconds>
 */
#define AUTO_REPORT_TEMPERATURES

/**
 * Auto-report position with M154 S<seconds>
 */
//#define AUTO_REPORT_POSITION

/**
 * Include capabilities in M115 output
 */
#define EXTENDED_CAPABILITIES_REPORT
#if ENABLED(EXTENDED_CAPABILITIES_REPORT)
  //#define M115_GEOMETRY_REPORT
#endif

/**
 * Expected Printer Check
 * Add the M16 G-code to compare a string to the MACHINE_NAME.
 * M16 with a non-matching string causes the printer to halt.
 */
//#define EXPECTED_PRINTER_CHECK

/**
 * Disable all Volumetric extrusion options
 */
//#define NO_VOLUMETRICS

#if DISABLED(NO_VOLUMETRICS)
  /**
   * Volumetric extrusion default state
   * Activate to make volumetric extrusion the default method,
   * with DEFAULT_NOMINAL_FILAMENT_DIA as the default diameter.
   *
   * M200 D0 to disable, M200 Dn to set a new diameter (and enable volumetric).
   * M200 S0/S1 to disable/enable volumetric extrusion.
   */
  //#define VOLUMETRIC_DEFAULT_ON

  //#define VOLUMETRIC_EXTRUDER_LIMIT
  #if ENABLED(VOLUMETRIC_EXTRUDER_LIMIT)
    /**
     * Default volumetric extrusion limit in cubic mm per second (mm^3/sec).
     * This factory setting applies to all extruders.
     * Use 'M200 [T<extruder>] L<limit>' to override and 'M502' to reset.
     * A non-zero value activates Volume-based Extrusion Limiting.
     */
    #define DEFAULT_VOLUMETRIC_EXTRUDER_LIMIT 0.00      // (mm^3/sec)
  #endif
#endif

/**
 * Enable this option for a leaner build of Marlin that removes all
 * workspace offsets, simplifying coordinate transformations, leveling, etc.
 *
 *  - M206 and M428 are disabled.
```

```
 *  - G92 will revert to its behavior from Marlin 1.0.
 */
//#define NO_WORKSPACE_OFFSETS

// Extra options for the M114 "Current Position" report
//#define M114_DETAIL         // Use 'M114` for details to check planner calculations
//#define M114_REALTIME       // Real current position based on forward kinematics
//#define M114_LEGACY         // M114 used to synchronize on every call. Enable if needed.

//#define REPORT_FAN_CHANGE   // Report the new fan speed when changed by M106 (and others)

/**
 * Set the number of proportional font spaces required to fill up a typical character space.
 * This can help to better align the output of commands like `G29 O` Mesh Output.
 *
 * For clients that use a fixed-width font (like OctoPrint), leave this set to 1.0.
 * Otherwise, adjust according to your client and font.
 */
#define PROPORTIONAL_FONT_RATIO 1.0

/**
 * Spend 28 bytes of SRAM to optimize the G-code parser
 */
#define FASTER_GCODE_PARSER

#if ENABLED(FASTER_GCODE_PARSER)
  //#define GCODE_QUOTED_STRINGS  // Support for quoted string parameters
#endif

// Support for MeatPack G-code compression (https://github.com/scottmudge/OctoPrint-MeatPack)
//#define MEATPACK_ON_SERIAL_PORT_1
//#define MEATPACK_ON_SERIAL_PORT_2

//#define GCODE_CASE_INSENSITIVE  // Accept G-code sent to the firmware in lowercase

//#define REPETIER_GCODE_M360     // Add commands originally from Repetier FW

/**
 * CNC G-code options
 * Support CNC-style G-code dialects used by laser cutters, drawing machine cams, etc.
 * Note that G0 feedrates should be used with care for 3D printing (if used at all).
 * High feedrates may cause ringing and harm print quality.
 */
//#define PAREN_COMMENTS      // Support for parentheses-delimited comments
//#define GCODE_MOTION_MODES  // Remember the motion mode (G0 G1 G2 G3 G5 G38.X) and apply for X Y Z E F, etc.

```

```
// Enable and set a (default) feedrate for all G0 moves
//#define G0_FEEDRATE 3000 // (mm/min)
#ifdef G0_FEEDRATE
  //#define VARIABLE_G0_FEEDRATE // The G0 feedrate is set by F in G0 motion mode
#endif

/**
 * Startup commands
 *
 * Execute certain G-code commands immediately after power-on.
 */
//#define STARTUP_COMMANDS "M17 Z"

/**
 * G-code Macros
 *
 * Add G-codes M810-M819 to define and run G-code macros.
 * Macros are not saved to EEPROM.
 */
//#define GCODE_MACROS
#if ENABLED(GCODE_MACROS)
  #define GCODE_MACROS_SLOTS       5  // Up to 10 may be used
  #define GCODE_MACROS_SLOT_SIZE  50  // Maximum length of a single macro
#endif

/**
 * User-defined menu items to run custom G-code.
 * Up to 25 may be defined, but the actual number is LCD-dependent.
 */

// Custom Menu: Main Menu
//#define CUSTOM_MENU_MAIN
#if ENABLED(CUSTOM_MENU_MAIN)
  //#define CUSTOM_MENU_MAIN_TITLE "Custom Commands"
  #define CUSTOM_MENU_MAIN_SCRIPT_DONE "M117 User Script Done"
  #define CUSTOM_MENU_MAIN_SCRIPT_AUDIBLE_FEEDBACK
  //#define CUSTOM_MENU_MAIN_SCRIPT_RETURN   // Return to status screen after a script
  #define CUSTOM_MENU_MAIN_ONLY_IDLE         // Only show custom menu when the machine is idle

  #define MAIN_MENU_ITEM_1_DESC "Home & UBL Info"
  #define MAIN_MENU_ITEM_1_GCODE "G28\nG29 W"
  //#define MAIN_MENU_ITEM_1_CONFIRM          // Show a confirmation dialog before this action

  #define MAIN_MENU_ITEM_2_DESC "Preheat for " PREHEAT_1_LABEL
  #define MAIN_MENU_ITEM_2_GCODE "M140 S" STRINGIFY(PREHEAT_1_TEMP_BED) "\nM104 S" STRINGIFY(PREHEAT_1_TEMP_HOTEND)
  //#define MAIN_MENU_ITEM_2_CONFIRM

  //#define MAIN_MENU_ITEM_3_DESC "Preheat for " PREHEAT_2_LABEL
  //#define MAIN_MENU_ITEM_3_GCODE "M140 S" STRINGIFY(PREHEAT_2_TEMP_BED) "\nM104 S" STRINGIFY(PREHEAT_2_TEMP_HOTEND)
  //#define MAIN_MENU_ITEM_3_CONFIRM

  //#define MAIN_MENU_ITEM_4_DESC "Heat Bed/Home/Level"
```

```
  //#define MAIN_MENU_ITEM_4_GCODE "M140 S" STRINGIFY(PREHEAT_2_TEMP_BED) "\nG28\nG29"
  //#define MAIN_MENU_ITEM_4_CONFIRM

  //#define MAIN_MENU_ITEM_5_DESC "Home & Info"
  //#define MAIN_MENU_ITEM_5_GCODE "G28\nM503"
  //#define MAIN_MENU_ITEM_5_CONFIRM
#endif

// Custom Menu: Configuration Menu
//#define CUSTOM_MENU_CONFIG
#if ENABLED(CUSTOM_MENU_CONFIG)
  //#define CUSTOM_MENU_CONFIG_TITLE "Custom Commands"
  #define CUSTOM_MENU_CONFIG_SCRIPT_DONE "M117 Wireless Script Done"
  #define CUSTOM_MENU_CONFIG_SCRIPT_AUDIBLE_FEEDBACK
  //#define CUSTOM_MENU_CONFIG_SCRIPT_RETURN  // Return to status screen after a script
  #define CUSTOM_MENU_CONFIG_ONLY_IDLE        // Only show custom menu when the machine is idle

  #define CONFIG_MENU_ITEM_1_DESC "Wifi ON"
  #define CONFIG_MENU_ITEM_1_GCODE "M118 [ESP110] WIFI-STA pwd=12345678"
  //#define CONFIG_MENU_ITEM_1_CONFIRM        // Show a confirmation dialog before this action

  #define CONFIG_MENU_ITEM_2_DESC "Bluetooth ON"
  #define CONFIG_MENU_ITEM_2_GCODE "M118 [ESP110] BT pwd=12345678"
  //#define CONFIG_MENU_ITEM_2_CONFIRM

  //#define CONFIG_MENU_ITEM_3_DESC "Radio OFF"
  //#define CONFIG_MENU_ITEM_3_GCODE "M118 [ESP110] OFF pwd=12345678"
  //#define CONFIG_MENU_ITEM_3_CONFIRM

  //#define CONFIG_MENU_ITEM_4_DESC "Wifi ????"
  //#define CONFIG_MENU_ITEM_4_GCODE "M118 ????"
  //#define CONFIG_MENU_ITEM_4_CONFIRM

  //#define CONFIG_MENU_ITEM_5_DESC "Wifi ????"
  //#define CONFIG_MENU_ITEM_5_GCODE "M118 ????"
  //#define CONFIG_MENU_ITEM_5_CONFIRM
#endif

/**
 * User-defined buttons to run custom G-code.
 * Up to 25 may be defined.
 */
//#define CUSTOM_USER_BUTTONS
#if ENABLED(CUSTOM_USER_BUTTONS)
  //#define BUTTON1_PIN -1
  #if PIN_EXISTS(BUTTON1)
    #define BUTTON1_HIT_STATE     LOW       // State of the triggered button. NC=LOW. NO=HIGH.
    #define BUTTON1_WHEN_PRINTING false     // Button allowed to trigger during printing?
    #define BUTTON1_GCODE         "G28"
    #define BUTTON1_DESC          "Homing"  // Optional string to set the LCD status
  #endif

```

```
  //#define BUTTON2_PIN -1
  #if PIN_EXISTS(BUTTON2)
    #define BUTTON2_HIT_STATE     LOW
    #define BUTTON2_WHEN_PRINTING false
    #define BUTTON2_GCODE         "M140 S" STRINGIFY(PREHEAT_1_TEMP_BED) "\nM104 S" STRINGIFY(PREHEAT_1_TEMP_HOTEND)
    #define BUTTON2_DESC          "Preheat for " PREHEAT_1_LABEL
  #endif

  //#define BUTTON3_PIN -1
  #if PIN_EXISTS(BUTTON3)
    #define BUTTON3_HIT_STATE     LOW
    #define BUTTON3_WHEN_PRINTING false
    #define BUTTON3_GCODE         "M140 S" STRINGIFY(PREHEAT_2_TEMP_BED) "\nM104 S" STRINGIFY(PREHEAT_2_TEMP_HOTEND)
    #define BUTTON3_DESC          "Preheat for " PREHEAT_2_LABEL
  #endif
#endif

/**
 * Host Action Commands
 *
 * Define host streamer action commands in compliance with the standard.
 *
 * See https://reprap.org/wiki/G-code#Action_commands
 * Common commands ........ poweroff, pause, paused, resume, resumed, cancel
 * G29_RETRY_AND_RECOVER .. probe_rewipe, probe_failed
 *
 * Some features add reason codes to extend these commands.
 *
 * Host Prompt Support enables Marlin to use the host for user prompts so
 * filament runout and other processes can be managed from the host side.
 */
//#define HOST_ACTION_COMMANDS
#if ENABLED(HOST_ACTION_COMMANDS)
  //#define HOST_PAUSE_M76
  //#define HOST_PROMPT_SUPPORT
  //#define HOST_START_MENU_ITEM  // Add a menu item that tells the host to start
#endif

/**
 * Cancel Objects
 *
 * Implement M486 to allow Marlin to skip objects
 */
//#define CANCEL_OBJECTS
#if ENABLED(CANCEL_OBJECTS)
  #define CANCEL_OBJECTS_REPORTING // Emit the current object as a status message
#endif

/**
 * I2C position encoders for closed loop control.
 * Developed by Chris Barr at Aus3D.
 *
 * Wiki: https://wiki.aus3d.com.au/Magnetic_Encoder
 * Github: https://github.com/Aus3D/MagneticEncoder
```

```
 *
 * Supplier: https://aus3d.com.au/magnetic-encoder-module
 * Alternative Supplier: https://reliabuild3d.com/
 *
 * Reliabuild encoders have been modified to improve reliability.
 */

//#define I2C_POSITION_ENCODERS
#if ENABLED(I2C_POSITION_ENCODERS)

  #define I2CPE_ENCODER_CNT         1                       // The number of encoders installed; max of 5
                                                            // encoders supported currently.

  #define I2CPE_ENC_1_ADDR          I2CPE_PRESET_ADDR_X     // I2C address of the encoder. 30-200.
  #define I2CPE_ENC_1_AXIS          X_AXIS                  // Axis the encoder module is installed on.  <X|Y|Z|E>_AXIS.
  #define I2CPE_ENC_1_TYPE          I2CPE_ENC_TYPE_LINEAR   // Type of encoder:  I2CPE_ENC_TYPE_LINEAR -or-
                                                            // I2CPE_ENC_TYPE_ROTARY.
  #define I2CPE_ENC_1_TICKS_UNIT    2048                    // 1024 for magnetic strips with 2mm poles; 2048 for
                                                            // 1mm poles. For linear encoders this is ticks / mm,
                                                            // for rotary encoders this is ticks / revolution.
  //#define I2CPE_ENC_1_TICKS_REV     (16 * 200)            // Only needed for rotary encoders; number of stepper
                                                            // steps per full revolution (motor steps/rev * microstepping)
  //#define I2CPE_ENC_1_INVERT                              // Invert the direction of axis travel.
  #define I2CPE_ENC_1_EC_METHOD     I2CPE_ECM_MICROSTEP     // Type of error error correction.
  #define I2CPE_ENC_1_EC_THRESH     0.10                    // Threshold size for error (in mm) above which the
                                                            // printer will attempt to correct the error; errors
                                                            // smaller than this are ignored to minimize effects of
                                                            // measurement noise / latency (filter).

  #define I2CPE_ENC_2_ADDR          I2CPE_PRESET_ADDR_Y     // Same as above, but for encoder 2.
  #define I2CPE_ENC_2_AXIS          Y_AXIS
  #define I2CPE_ENC_2_TYPE          I2CPE_ENC_TYPE_LINEAR
  #define I2CPE_ENC_2_TICKS_UNIT    2048
  //#define I2CPE_ENC_2_TICKS_REV   (16 * 200)
  //#define I2CPE_ENC_2_INVERT
  #define I2CPE_ENC_2_EC_METHOD     I2CPE_ECM_MICROSTEP
  #define I2CPE_ENC_2_EC_THRESH     0.10

  #define I2CPE_ENC_3_ADDR          I2CPE_PRESET_ADDR_Z     // Encoder 3. Add additional configuration options
  #define I2CPE_ENC_3_AXIS          Z_AXIS                  // as above, or
```

```
use defaults below.

  #define I2CPE_ENC_4_ADDR          I2CPE_PRESET_ADDR_E     // Encoder 4.
  #define I2CPE_ENC_4_AXIS          E_AXIS

  #define I2CPE_ENC_5_ADDR          34                      // Encoder 5.
  #define I2CPE_ENC_5_AXIS          E_AXIS

  // Default settings for encoders which are enabled, but without settings
configured above.
  #define I2CPE_DEF_TYPE            I2CPE_ENC_TYPE_LINEAR
  #define I2CPE_DEF_ENC_TICKS_UNIT  2048
  #define I2CPE_DEF_TICKS_REV       (16 * 200)
  #define I2CPE_DEF_EC_METHOD       I2CPE_ECM_NONE
  #define I2CPE_DEF_EC_THRESH       0.1

  //#define I2CPE_ERR_THRESH_ABORT  100.0                   // Threshold
size for error (in mm) error on any given
                                                            // axis after
which the printer will abort. Comment out to
                                                            // disable abort
behavior.

  #define I2CPE_TIME_TRUSTED        10000                   // After an
encoder fault, there must be no further fault
                                                            // for this
amount of time (in ms) before the encoder
                                                            // is trusted
again.

  /**
   * Position is checked every time a new command is executed from the
buffer but during long moves,
   * this setting determines the minimum update time between checks. A value
of 100 works well with
   * error rolling average when attempting to correct only for skips and not
for vibration.
   */
  #define I2CPE_MIN_UPD_TIME_MS     4                       // (ms) Minimum
time between encoder checks.

  // Use a rolling average to identify persistent errors that indicate
skips, as opposed to vibration and noise.
  #define I2CPE_ERR_ROLLING_AVERAGE

#endif // I2C_POSITION_ENCODERS

/**
 * Analog Joystick(s)
 */
//#define JOYSTICK
#if ENABLED(JOYSTICK)
  #define JOY_X_PIN    5  // RAMPS: Suggested pin A5  on AUX2
  #define JOY_Y_PIN   10  // RAMPS: Suggested pin A10 on AUX2
  #define JOY_Z_PIN   12  // RAMPS: Suggested pin A12 on AUX2
  #define JOY_EN_PIN  44  // RAMPS: Suggested pin D44 on AUX2

  //#define INVERT_JOY_X  // Enable if X direction is reversed
```

```
  //#define INVERT_JOY_Y  // Enable if Y direction is reversed
  //#define INVERT_JOY_Z  // Enable if Z direction is reversed

  // Use M119 with JOYSTICK_DEBUG to find reasonable values after connecting:
  #define JOY_X_LIMITS { 5600, 8190-100, 8190+100, 10800 } // min, deadzone start, deadzone end, max
  #define JOY_Y_LIMITS { 5600, 8250-100, 8250+100, 11000 }
  #define JOY_Z_LIMITS { 4800, 8080-100, 8080+100, 11550 }
  //#define JOYSTICK_DEBUG
#endif

/**
 * Mechanical Gantry Calibration
 * Modern replacement for the Prusa TMC_Z_CALIBRATION.
 * Adds capability to work with any adjustable current drivers.
 * Implemented as G34 because M915 is deprecated.
 */
//#define MECHANICAL_GANTRY_CALIBRATION
#if ENABLED(MECHANICAL_GANTRY_CALIBRATION)
  #define GANTRY_CALIBRATION_CURRENT          600     // Default calibration current in ma
  #define GANTRY_CALIBRATION_EXTRA_HEIGHT      15     // Extra distance in mm past Z_###_POS to move
  #define GANTRY_CALIBRATION_FEEDRATE         500     // Feedrate for correction move
  //#define GANTRY_CALIBRATION_TO_MIN                 // Enable to calibrate Z in the MIN direction

  //#define GANTRY_CALIBRATION_SAFE_POSITION XY_CENTER // Safe position for nozzle
  //#define GANTRY_CALIBRATION_XY_PARK_FEEDRATE 3000  // XY Park Feedrate - MMM
  //#define GANTRY_CALIBRATION_COMMANDS_PRE   ""
  #define GANTRY_CALIBRATION_COMMANDS_POST  "G28"     // G28 highly recommended to ensure an accurate position
#endif

/**
 * Instant freeze / unfreeze functionality
 * Specified pin has pullup and connecting to ground will instantly pause motion.
 * Potentially useful for emergency stop that allows being resumed.
 */
//#define FREEZE_FEATURE
#if ENABLED(FREEZE_FEATURE)
  //#define FREEZE_PIN 41   // Override the default (KILL) pin here
#endif

/**
 * MAX7219 Debug Matrix
 *
 * Add support for a low-cost 8x8 LED Matrix based on the Max7219 chip as a realtime status display.
 * Requires 3 signal wires. Some useful debug options are included to demonstrate its usage.
 */
//#define MAX7219_DEBUG
#if ENABLED(MAX7219_DEBUG)
```

```
#if ENABLED(MAX7219_DEBUG)
  #define MAX7219_CLK_PIN   64
  #define MAX7219_DIN_PIN   57
  #define MAX7219_LOAD_PIN  44

  //#define MAX7219_GCODE          // Add the M7219 G-code to control the LED matrix
  #define MAX7219_INIT_TEST    2   // Test pattern at startup: 0=none, 1=sweep, 2=spiral
  #define MAX7219_NUMBER_UNITS 1   // Number of Max7219 units in chain.
  #define MAX7219_ROTATE       0   // Rotate the display clockwise (in multiples of +/- 90°)
                                   // connector at:  right=0   bottom=-90  top=90  left=180
  //#define MAX7219_REVERSE_ORDER  // The individual LED matrix units may be in reversed order
  //#define MAX7219_SIDE_BY_SIDE   // Big chip+matrix boards can be chained side-by-side

  /**
   * Sample debug features
   * If you add more debug displays, be careful to avoid conflicts!
   */
  #define MAX7219_DEBUG_PRINTER_ALIVE    // Blink corner LED of 8x8 matrix to show that the firmware is functioning
  #define MAX7219_DEBUG_PLANNER_HEAD  3  // Show the planner queue head position on this and the next LED matrix row
  #define MAX7219_DEBUG_PLANNER_TAIL  5  // Show the planner queue tail position on this and the next LED matrix row

  #define MAX7219_DEBUG_PLANNER_QUEUE 0  // Show the current planner queue depth on this and the next LED matrix row
                                         // If you experience stuttering, reboots, etc. this option can reveal how
                                         // tweaks made to the configuration are affecting the printer in real-time.
#endif

/**
 * NanoDLP Sync support
 *
 * Support for Synchronized Z moves when used with NanoDLP. G0/G1 axis moves will
 * output a "Z_move_comp" string to enable synchronization with DLP projector exposure.
 * This feature allows you to use [[WaitForDoneMessage]] instead of M400 commands.
 */
//#define NANODLP_Z_SYNC
#if ENABLED(NANODLP_Z_SYNC)
  //#define NANODLP_ALL_AXIS  // Send a "Z_move_comp" report for any axis move (not just Z).
#endif

/**
 * Ethernet. Use M552 to enable and set the IP address.
 */
#if HAS_ETHERNET
  #define MAC_ADDRESS { 0xDE, 0xAD, 0xBE, 0xEF, 0xF0, 0x0D }  // A MAC
```

```
address unique to your network
#endif

/**
 * WiFi Support (Espressif ESP32 WiFi)
 */
//#define WIFISUPPORT         // Marlin embedded WiFi managenent
//#define ESP3D_WIFISUPPORT   // ESP3D Library WiFi management (https://github.com/luc-github/ESP3DLib)

#if EITHER(WIFISUPPORT, ESP3D_WIFISUPPORT)
  //#define WEBSUPPORT          // Start a webserver (which may include auto-discovery)
  //#define OTASUPPORT          // Support over-the-air firmware updates
  //#define WIFI_CUSTOM_COMMAND // Accept feature config commands (e.g., WiFi ESP3D) from the host

  /**
   * To set a default WiFi SSID / Password, create a file called Configuration_Secure.h with
   * the following defines, customized for your network. This specific file is excluded via
   * .gitignore to prevent it from accidentally leaking to the public.
   *
   *   #define WIFI_SSID "WiFi SSID"
   *   #define WIFI_PWD  "WiFi Password"
   */
  //#include "Configuration_Secure.h" // External file with WiFi SSID / Password
#endif

/**
 * Průša Multi-Material Unit (MMU)
 * Enable in Configuration.h
 *
 * These devices allow a single stepper driver on the board to drive
 * multi-material feeders with any number of stepper motors.
 */
#if HAS_PRUSA_MMU1
  /**
   * This option only allows the multiplexer to switch on tool-change.
   * Additional options to configure custom E moves are pending.
   *
   * Override the default DIO selector pins here, if needed.
   * Some pins files may provide defaults for these pins.
   */
  //#define E_MUX0_PIN 40  // Always Required
  //#define E_MUX1_PIN 42  // Needed for 3 to 8 inputs
  //#define E_MUX2_PIN 44  // Needed for 5 to 8 inputs
#elif HAS_PRUSA_MMU2
  // Serial port used for communication with MMU2.
  #define MMU2_SERIAL_PORT 2

  // Use hardware reset for MMU if a pin is defined for it
  //#define MMU2_RST_PIN 23

  // Enable if the MMU2 has 12V stepper motors (MMU2 Firmware 1.0.2 and up)
  //#define MMU2_MODE_12V
```

```
  // G-code to execute when MMU2 F.I.N.D.A. probe detects filament runout
  #define MMU2_FILAMENT_RUNOUT_SCRIPT "M600"

  // Add an LCD menu for MMU2
  //#define MMU2_MENUS
  #if EITHER(MMU2_MENUS, HAS_PRUSA_MMU2S)
    // Settings for filament load / unload from the LCD menu.
    // This is for Průša MK3-style extruders. Customize for your hardware.
    #define MMU2_FILAMENTCHANGE_EJECT_FEED 80.0
    #define MMU2_LOAD_TO_NOZZLE_SEQUENCE \
      {  7.2, 1145 }, \
      { 14.4,  871 }, \
      { 36.0, 1393 }, \
      { 14.4,  871 }, \
      { 50.0,  198 }

    #define MMU2_RAMMING_SEQUENCE \
      {   1.0, 1000 }, \
      {   1.0, 1500 }, \
      {   2.0, 2000 }, \
      {   1.5, 3000 }, \
      {   2.5, 4000 }, \
      { -15.0, 5000 }, \
      { -14.0, 1200 }, \
      {  -6.0,  600 }, \
      {  10.0,  700 }, \
      { -10.0,  400 }, \
      { -50.0, 2000 }
  #endif

  /**
   * Using a sensor like the MMU2S
   * This mode requires a MK3S extruder with a sensor at the extruder idler, like the MMU2S.
   * See https://help.prusa3d.com/en/guide/3b-mk3s-mk2-5s-extruder-upgrade_41560, step 11
   */
  #if HAS_PRUSA_MMU2S
    #define MMU2_C0_RETRY   5             // Number of retries (total time = timeout*retries)

    #define MMU2_CAN_LOAD_FEEDRATE 800    // (mm/min)
    #define MMU2_CAN_LOAD_SEQUENCE \
      {  0.1, MMU2_CAN_LOAD_FEEDRATE }, \
      {  60.0, MMU2_CAN_LOAD_FEEDRATE }, \
      { -52.0, MMU2_CAN_LOAD_FEEDRATE }

    #define MMU2_CAN_LOAD_RETRACT   6.0   // (mm) Keep under the distance between Load Sequence values
    #define MMU2_CAN_LOAD_DEVIATION 0.8   // (mm) Acceptable deviation

    #define MMU2_CAN_LOAD_INCREMENT 0.2   // (mm) To reuse within MMU2 module
    #define MMU2_CAN_LOAD_INCREMENT_SEQUENCE \
      { -MMU2_CAN_LOAD_INCREMENT, MMU2_CAN_LOAD_FEEDRATE }

  #else
```

```
    /**
     * MMU1 Extruder Sensor
     *
     * Support for a Průša (or other) IR Sensor to detect filament near the extruder
     * and make loading more reliable. Suitable for an extruder equipped with a filament
     * sensor less than 38mm from the gears.
     *
     * During loading the extruder will stop when the sensor is triggered, then do a last
     * move up to the gears. If no filament is detected, the MMU2 can make some more attempts.
     * If all attempts fail, a filament runout will be triggered.
     */
    //#define MMU_EXTRUDER_SENSOR
    #if ENABLED(MMU_EXTRUDER_SENSOR)
      #define MMU_LOADING_ATTEMPTS_NR 5 // max. number of attempts to load filament if first load fail
    #endif

  #endif

  //#define MMU2_DEBUG  // Write debug info to serial output

#endif // HAS_PRUSA_MMU2

/**
 * Advanced Print Counter settings
 */
#if ENABLED(PRINTCOUNTER)
  #define SERVICE_WARNING_BUZZES  3
  // Activate up to 3 service interval watchdogs
  //#define SERVICE_NAME_1      "Service S"
  //#define SERVICE_INTERVAL_1  100 // print hours
  //#define SERVICE_NAME_2      "Service L"
  //#define SERVICE_INTERVAL_2  200 // print hours
  //#define SERVICE_NAME_3      "Service 3"
  //#define SERVICE_INTERVAL_3    1 // print hours
#endif

// @section develop

//
// M100 Free Memory Watcher to debug memory usage
//
//#define M100_FREE_MEMORY_WATCHER

//
// M42 - Set pin states
//
//#define DIRECT_PIN_CONTROL

//
// M43 - display pin status, toggle pins, watch pins, watch endstops & toggle LED, test servo probe
//
//#define PINS_DEBUGGING
```

```
// Enable Marlin dev mode which adds some special commands
//#define MARLIN_DEV_MODE

#if ENABLED(MARLIN_DEV_MODE)
  /**
   * D576 - Buffer Monitoring
   * To help diagnose print quality issues stemming from empty command buffers.
   */
  //#define BUFFER_MONITORING
#endif

/**
 * Postmortem Debugging captures misbehavior and outputs the CPU status and backtrace to serial.
 * When running in the debugger it will break for debugging. This is useful to help understand
 * a crash from a remote location. Requires ~400 bytes of SRAM and 5Kb of flash.
 */
//#define POSTMORTEM_DEBUGGING

/**
 * Software Reset options
 */
//#define SOFT_RESET_VIA_SERIAL         // 'KILL' and '^X' commands will soft-reset the controller
//#define SOFT_RESET_ON_KILL            // Use a digital button to soft-reset the controller after KILL

```